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GEORGE OTIS SMITH, DIRECTOR

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CALENDAR YEAR

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MINERAL RESOURCES OF THE UNITED STATES FOR 1909—PART II.

COAL.

By Edward W. Parker.

INTRODUCTION.

COOPERATION WITH BUREAU OF THE CENSUS.

The statistics of the production of coal in 1909, as of those of other mineral substances, were collected under a plan of cooperation between the United States Geological Survey and the United States Bureau of the Census. This cooperation has resulted in possibly a more complete canvass than is practicable in the conduct of an investigation where the returns are made for the most part by mail, but the benefit thus derived has been seriously modified, if not rendered nugatory, by the regrettable delays that have retarded the publication of the report. As it is, this publication for 1909 is issued at a time when the collection of the statistics of 1910 is well under way.

ACKNOWLEDGMENTS.

The writer desires to reiterate the acknowledgments for cooperation in the preparation of these reports of the individual operators and the officials of corporations, without whose good will and confidence it would be impossible to compile the statistics with the completeness with which they are presented in these pages. Acknowledgments are also due to Mr. William M. Steuart and other officials of the Bureau of the Census, who have made every possible effort to carry out in good faith the plan of cooperation between that bureau and the Geological Survey. The statistics relating to mine accidents have been compiled through the kind assistance of state officials, and proper recognition by name is made in the portions of the paper in which those statistics are discussed, and the same is true for the contributions, by secretaries of boards of trade and other local authorities, to that portion of the report included under the caption "Coal trade review." The writer would lack appreciation if he did not also recognize the faithful and efficient services of his clerical and stenographic assistants in the Geological Survey.

UNIT OF MEASUREMENT.

The standard unit of measurement adopted for this report is the short ton of 2,000 pounds, although it is necessary in a few instances to use the long ton. All of the anthracite product is mined and sold on the basis of the long ton of 2,240 pounds. Hence, when the production of Pennsylvania anthracite is considered, the long ton is used. The long ton is also used in the statistics of imports and exports. In all other cases where the production is reported in long tons the figures have been reduced to short tons, and unless otherwise expressly stated the short ton is meant where any statement of quantity is made in the text.

GENERAL FEATURES OF COAL MINING IN 1909.

The year 1909, as recorded in its production of coal, showed a a substantial recovery from the business depression of 1908 but did not reach the high-water mark attained in 1907, the banner year of industrial activity in this country. The recovery from the depression of 1908 was more marked in the metal-mining States of the West than in the manufacturing States of the East, and in most of the coal-producing States of the Rocky Mountain region the output exceeded that of the record-breaking year 1907. In the Eastern States production would probably have been larger except for a marked scarcity of labor. Many of the miners and laborers employed in the coal mines, particularly in the East, are foreigners, and large numbers of them took advantage of the slack demand for labor in 1908 to visit their native lands. The shortage of labor thus created was seriously felt by the coal industry in 1909. In the later months of the year, when the approach of cold weather increased the demand created by the business revival, there was also the usual complaint of car shortage. It is admitted, however, that if the supply of labor and of cars had been sufficient to meet the capacity of the mines the production would have been considerably in excess of the requirements. As it was there was a general falling off in prices, as is shown by the averages by States and counties. Such falling off does not always mean a lower value for the same grades of coal, for in "flush times" it is influenced to some extent by the ability of operators to market a larger percentage of slack and other less desirable grades, whereas in lean years buyers are more exacting in their requirements. During the later part of 1909 mining operations in some of the Eastern States, particularly in the anthracite region of Pennsylvania and in the coking districts, were seriously hampered by a scarcity of water.

Labor troubles were for the most part of a negligible character. It was an "off" year for the bituminous miners whose wage agreements are for two years and terminate on March 31 of the "even" years. There was some apprehension of a suspension on April 1 in the anthracite mines, as the three-year renewal of the anthracite commission's awards terminated on that date, and in the later part of 1908 and for the first three months of 1909 anthracite mining was actively pushed in anticipation of a shut down. In slightly changed form, however, the awards were again renewed for another term of three years without a suspension. After the renewal production fell off and the shipments for the summer months of 1909 were the smallest in recent years.

SUMMARY OF STATISTICS IN 1909.

Total production in 1909, 460,803,416 short tons; spot value, $554,902,624.

Pennsylvania anthracite.—Total production in 1909, 72,374,249 long tons (equivalent to 81,059,159 short tons); spot value, $149,415,847.

Bituminous and lignite.—Total production in 1909, 379,744,257 short tons; spot value, $405,486,777.

Although the production of coal in 1909 exceeded that of 1908 by nearly 45,000,000 short tons, it was still almost 20,000,000 tons short of the record-making output of 1907. From an output of 480,363,424 short tons, valued at $614,798,898, in 1907, the production dropped to 415,842,698 short tons, valued at $532,314,117 in 1908, and then increased with the business revival to 460,803,416 short tons, valued at $554,902,624, in 1909. This increase was altogether in the production of bituminous coal, as the production of anthracite in Pennsylvania decreased from 74,347,102 long tons (or 83,268,754 short tons), valued at $158,178,849, in 1908, to 72,374,249 long tons (or 81,059,159 short tons), valued at $149,415,847, in 1909, a difference against 1909 of 1,972,853 long tons (or 2,209,595 short tons), in quantity, and of $8,763,002 in value. The production of bituminous coal increased from 332,573,944 short tons, valued at $374,135,268, in 1908, to 379,744,257 short tons, valued at $405,486,777, in 1909, a gain of 47,170,313 short tons, or 14.2 per cent, in quantity, and of $31,351,509, or 8.4 per cent, in value. The net increase in production in 1909 was 44,960,718 short tons, or 10.8 per cent, from 415,842,698 short tons in 1908 to 460,803,416 short tons in 1909. The value increased $22,588,507, or 4.2 per cent, from $532,314,117 to $554,902,624.

Included under the general head of bituminous coals are semianthracite, semibituminous, cannel, splint, and subbituminous coals and lignites; also small quantities of anthracite mined in Colorado and New Mexico. Unless otherwise stated, when reference is made to anthracite the production in Pennsylvania alone is considered.

In percentage of increase, though not in quantity, the Western States led those in the East, and in Montana, New Mexico, North Dakota, Texas, Utah, Wyoming, Iowa, and Oregon the production in 1909 exceeded the previous maximum of 1907. Colorado was the only one of the Rocky Mountain States whose production in 1909 was less than in 1907, and Indiana, Virginia, and West Virginia were the only States east of the Mississippi whose output in 1909 exceeded that of 1907. In Texas the production in 1909 was less than in 1908, but more than that of 1907. Besides Texas there were five States whose production decreased from 1908 to 1909, namely, Georgia, Idaho, Maryland, Michigan, and Massachusetts. In the last-named State a small production of lignite (50 tons) was mined at Vineyard Haven in 1908, and no output from this source was reported in 1909. The total decrease in the six States was less than 600,000 tons. The largest increase was in the production of bituminous coal in Pennsylvania, which showed a gain of 20,787,264 short tons. West Virginia made the second largest increase (9,951,377 short tons), and through this increase took precedence over Illinois and for the second time became the second State in coal-producing importance. Illinois gained 3,245,300 short tons; Indiana, 2,519,369 tons; Alabama, 2,098,857 tons; Ohio, 1,669,002 tons; and Colorado, 1,081,963 tons. Of these seven leading States those showing the largest percentage of increase were Indiana, West Virginia, and Alabama, the percentage of gain being, respectively, 20.4, 23.7, and 18.1.

Notwithstanding the improved industrial conditions in 1909 as compared with 1908 and the better demand for coal, prices showed a general and in some cases a marked decline. The average price per short ton for Pennsylvania anthracite declined from $1.90 in 1908 to $1.84. The average price for all bituminous coals, lignites, etc., declined from $1.12 to $1.07.

Out of the 29 States in which coal was produced in 1909, there were 22 in which the average price for coal was less than in 1908. In 6 States, namely, Georgia, Idaho, Iowa, Missouri, Montana, and Washington, advances were shown in 1909 in the average price, and in Illinois it was the same for the two years.

The relative falling off in value in the bituminous coal-producing States was due largely to coal brought into the markets from the opening of new mines during the "flush times" prior to 1908. Stimulated by the continued prosperity and rapidly increasing development of the iron and steel trade and in other manufacturing industries, owners of coal properties, wherever transportation facilities were available, were impelled to open their mines in order to take advantage of the favorable opportunities to market the product, notwithstanding the fact that with full complements of men and with ample car supplies the properties already developed were capable of furnishing from 50 to 75 per cent more than their regular output. The competition resulting from the increased productive capacity had the natural result of lowering prices. Another factor influencing values is the ability of operators to get rid of some of the less desirable grades in years of plenty, whereas in times of depression consumers are more exacting in their demands. In 1908, for example, large quantities of slack and other low grades of coal were thrown on the dumps; in 1909 operators were better able to dispose of more of this portion of the product for that year and also in some cases to reduce the size of the slack dumps. The enormous increase in the manufacture of Portland cement, in which powdered fuel is extensively used, has furnished a market for large quantities of bituminous slack, which while apparently reducing the average price, actually in some cases means better returns to the producers. These factors must all be considered in any study of the rise and fall in price. The decline in the price of anthracite was due in part to a larger proportion of small sizes recovered by washeries from the unsightly culm heaps, which by this means are fortunately being removed from the landscape in that region.

It should also be remembered that the small sizes of anthracite which are sold for steam purposes, whether from the culm banks or from the freshly mined coal, are sold at prices less than the actual cost of producing run-of-mine coal. The same is true of bituminous slack coal in the noncoking-coal regions.

Attention has been called in previous reports to the rapid growth in the coal-mining industry and to the fact that in each decade the output has been practically doubled. The year 1908 was a notable exception to the general increase, but it was essentially an exception. A continual increase in the annual production may be looked for when the country has recovered from the effects of the financial depression of that year.

The statistics of coal production in the past show that up to the close of 1865 the total output had amounted to 284,890,055 short tons. In the decade from 1866 to 1875, inclusive, the production amounted to 419,425,104 tons, making the total production up to the close of 1875, 704,315,159 tons. In the following decade, from 1876 to 1885, inclusive, the output amounted to 847,760,319 tons, somewhat more than double the total production for the preceding decade. At the close of 1885 the total production amounted to 1,552,075,478 tons, and the production for the ten years ending with 1895 was 1,586,098,641 tons, the total production to the close of 1895 amounting to 3,138,174,119 short tons. In the decade ending December 31, 1905, the total production amounted to 2,832,402,746 short tons, and the grand total from the beginning of coal mining amounted to 5,970,576,865 short tons. The average annual production from 1896 to 1905 was 283,240,275 short tons, compared with which the average production for the four years from 1906 to 1909, inclusive, was 442,791,704 short tons, showing an increase of159,551,-429 short tons, or 56.3 per cent.

This great increase in the production of coal, when considered with the increase in the population, furnishes some further interesting comparisons. Going back for a period of a little over fifty years, or to the middle of the last century, and comparing the statistics of coal production with the increased population, it is found that in 1850, according to the United States census for that year, the production of coal amounted to 6,445,681 tons when the population of the country amounted to 23,191,876 persons. The per capita production of coal in that year is thus seen to have been 0.278 ton. In 1860, ten years later, the population was 31,443,321 persons, and the coal production amounted to 16,139,736 tons, or an average of 0.514 ton per person. At the census of 1870 the population of the United States amounted to 38,558,371; the coal production of that year amounted to 36,806,560 short tons, a per capita average of 0.96 ton. Ten years later, when the population was 50,189,209, the coal output amounted to 76,157,944 short tons, or 1.52 tons per capita. In 1890 the population had grown to 63,069,756, an increase of 25 per cent over 1880, and the coal production had grown to 157,770,963 short tons, or a per capita production of 2.52 tons. At the taking of the Twelfth Census, in 1900, when the increase in population amounted to 22 per cent, the total number of persons reported being 76,303,387, more than 70 per cent had been added to the coal production, with a total of 269,684,027 short tons, or an average of 3.53 tons for each inhabitant. In other words, while the population was increasing 230 per cent, from 1850 to 1900, the production of coal increased 4,084 per cent. The Director of the Bureau of the Census estimated the population of the United States on June 1, 1907, at about 85,500,-000 persons, making the per capita production in that year 5.6 tons; so that in less than sixty years the per capita production of coal in the United States had increased from a little more than one-quarter of a ton to 5½ tons. Estimating the population of the United States in 1908 at 87,000,000 persons, the per capita production for that year is found to have been 4.78 short tons. The report of the Thirteenth

Census on population shows that on April 15, 1910, the United States numbered 91,972,266 persons, from which it appears that the population during 1909 was approximately 90,000,000, indicating that the per capita coal production in that year was 5.1 short tons.

It is true that in the earlier years covered by this summary the proportion of wood used for fuel was larger than it is at the present time, but the actual consumption of wood for fuel purposes is probably as great to-day, or possibly greater, than it was fifty years ago. It should also be remembered that in addition to the production of coal there has been a great increase in the use of oil for fuel purposes, and natural gas still remains an important factor in this regard. The consumption of petroleum for fuel purposes in 1909 was probably equivalent to 16,000,000 short tons of coal.

According to a preliminary compilation made by the Mining Division of the Bureau of the Census, there were 666,555 men employed in the coal mines of the United States in 1909, against 690,438 men in 1908 and 680,492 men in 1907, as reported to the Geological Survey. Unfortunately, the statistics regarding the number of days worked in 1909, as collected by the Bureau of the Census, are not available at the time of writing this report, and if available would not be compiled in a manner that would furnish comparisons with previous years. From the figures available it appears that the average production by each man employed in 1909 was 691 short tons, against 602 tons in 1908 and 713 tons in 1907. In the anthracite mines, for which the Bureau of the Census reports a total of 166,801 men, the average production was 486 short tons, against 478 tons in 1908 and 512 tons in 1907. The number of men reported for the bituminous mines was 499,754, and the average production per man was 759 tons, against 644 tons in 1908 and 769 tons in 1907.

The use of machinery for mining bituminous coal grows steadily and the percentage of machine-mined coal to the total product increases each year. This modern development materially mitigates the exacting character of the coal miner's occupation, and, it is hoped, also reduces the reprehensible practice of shooting from the solid. In the proportion that such practice is reduced so, it is maintained by many, is the liability to accidents lessened and the greater safety of life, limb, and property achieved. An interesting advance in the manufacture of mining machines within the last two years has been the bringing out, by several different manufacturers, of a type of machine for undercutting or shearing coal or cutting out clay bands in the coal and adapted for use in steeply inclined beds. Some of these machines, which are discussed more fully in the subsequent pages of this report, were used in 1909 and contributed to the machine-mined tonnage of the year.

The total quantity of bituminous coal (and lignite) mined by the use of machines in 1909 was 142,496,878 short tons, an increase of 19,313,544 tons, or 15.7 per cent, over the machine-mined product of 123,183,334 short tons in 1908. The States in which machine mining is practiced produced in 1909 a total of 374,688,540 short tons of bituminous coal and lignite. Of this the machine-mined coal represented 38 per cent. In 1908 the machine-mined coal represented 37.5 per cent, and in 1907 it represented 35.71 per cent of the total production in the States where mining machines are employed. The machine-mined coal was 37.5 per cent of the total production of bituminous coal in all States in 1909 and 37 per cent of the total production in 1908. The number of mining machines in use in 1909 was 13,049, against 11,569 in 1908 and 11,144 in 1907, the average production for each machine being 12,381 short tons in 1907, 10,648 in 1908, and 10,920 in 1909. Of the 13,049 machines in use, 7,107 were punchers (including those of the new type for steeply inclined beds), 5,590 were chain-breast machines, and 352 were long wall. The number of long-wall machines as given includes a few "short-wall" machines and "continuous cutters," and there are a few punchers and chain-breast machines included in these types of machines that were used for shearing. There are some mines in which more than one type of machines are used, but there are enough in which the punchers or chain machines are used exclusively to give some interesting comparisons. Of the total number of punching machines reported in 1909, 5,591 that were used in mines in which no other machines were employed produced 39,355,829 short tons, whereas 4,253 chain machines produced 69,926,367 tons. The average for the punching machines was 7,039 tons each and that for the chain machines was 16,442 tons. The difference in productive efficiency is not so much as these figures indicate, for although in straight mining the chain machine will produce more coal than the puncher, the latter is also used in entry and other narrow work to which the chain machine is not adapted, and the tonnage won in such work is much less than in straight mining.

Pennsylvania, the leading State in the total production of bituminous coal, leads also in the number of machines employed and in the quantity of coal mined by them, but in the percentage of machine-mined coal to the total product Ohio takes first place. The bituminous mines of Pennsylvania employed 5,616 machines in 1909, which produced 57,504,188 short tons, or 41.68 per cent of the State's total production of bituminous coal. Ohio mines employed 1,433 machines, that mined 22,148,216 tons, or 79.5 per cent of the State's total. Of the 5,616 machines in Pennsylvania, 3,847 were punchers; of the 1,433 machines in Ohio, 1,314, or 92 per cent, were chain machines. Ohio was second in the quantity of machine-mined tonnage, with West Virginia third and Illinois fourth. Kentucky is second in the percentage of machine-mined coal, with Indiana third, Pennsylvania fourth, and West Virginia fifth.

The year 1909 was an "off" year in labor troubles. In the bituminous coal-producing States where operations are carried on under agreements with the United Mine Workers of America the compacts are for two years and terminate on March 31 of the "even" years. Consequently in 1909 there was no general strike or suspension. Local disaffections, of course, occurred, but they were generally of short duration and were not sufficient to affect the total production. There was some apprehension of a shutdown in the anthracite region as the renewal of the strike commission's awards which were made in April, 1906, for a second period of three years, terminated on March 31, 1909. In anticipation of a struggle mining was actively pushed for several months prior to that date, but fortunately it proved unnecessary, as with only immaterial modifications the awards were by common consent extended for another three years, making nine years in all that the operators and miners will have worked in harmony and with peace and prosperity to the region and industry under the commission's awards. The summation of the strikes or suspensions was 25,534 men idle for an average of twenty-nine days each. In 1908 145,145 men were idle for an average of thirty-eight days each, entailing a total lost time of 5,449,938 working-days. When the history of 1910 is written the record will probably be worse than that of 1908.

In the presentation of the statistics of accidents the United States Geological Survey has relied upon figures furnished through the courtesy of state inspection or statistical bureaus, except that in 1909 figures are included from four States, namely, Georgia, Oregon, Texas, and Virginia, the accident statistics of which were compiled from reports made by operators to the Survey. Notwithstanding the increased tonnage in 1909, it is gratifying to be able to record fewer fatalities in the mines, though there was an increase in the number of nonfatal accidents. The total number of men killed in the coal mines in 1909 was 2,412, against 2,451 in 1908, a decrease of 39. The total number of injuries was 7,979 in 1909, against 6,772 in 1908. Of the total number of deaths in 1909 those in the anthracite region of Pennsylvania were 567, while the fatalities in the bituminous mines numbered 1,845. The statistics of the number of men employed are incomplete, but from preliminary compilations made by the Census Bureau the death rate per thousand of men employed was 3.62. There were 142,961 tons of anthracite and 205,823 tons of bituminous coal mined for each life lost.

The production of anthracite in Pennsylvania includes a considerable quantity of coal recovered from the old culm banks by washeries. The recovery of this product in 1909 amounted to 3,694,470 long tons, or 4,137,806 short tons. By means of dredges 96,239 long tons, or 107,788 short tons, were recovered from the bed of Susquehanna River. A considerable quantity of bituminous coal is washed, each year, the most of which is used in the manufacture of coke. In Illinois, however, the coal which is washed is principally nut coal sold for domestic purposes.

The total quantity of bituminous coal washed in 1909 was 16,541,874 short tons, from which 14,443,147 tons of cleaned coal were obtained, the refuse amounting to 2,098,727 tons. More than one-third of the washed coal was Alabama coal used for coke making; one-fourth was from Illinois, and one-fifth from Pennsylvania.

Practically the entire output of both anthracite and bituminous coal in the United States is consumed within the country. The total exports of coal in 1909 amounted to 14,040,944 short tons, which, deducted from the production of 460,803,416 tons, shows a consumption of coal of domestic production amounting to 446,762,472 short tons. If to this are added the imports, which in 1909 amounted to 1,431,465 short tons, the total consumption of coal in the United States in 1909 (considering as negligible the stocks on hand at the beginning and end of the year) is shown to have been 448,193,937 tons, which is equivalent to 97 per cent of the domestic production.

Most of the coal imported into the United States is classed as bituminous or shale, only a comparatively small quantity of anthracite being brought into this country. The imports of bituminous coal are principally to points on the Pacific coast and to the port of Boston, where considerable quantities of bituminous slack are imported from Canada and used at the Otto-Hoffmann coke ovens at

Everett, near Boston. The exports of both anthracite and bituminous coal are principally to Canada.

The statistics of coal production as presented in these reports include not only the coal marketed, either by shipment to distant points or sold locally, but that consumed by mine employees and by the mine owners in the operation of the collieries. The latter factor is usually considered and reported as colliery consumption. There are occasional exceptions in the bituminous fields, where the operators, who use only slack, an otherwise waste product, do not report this item in their statement of production and do not deem it of any value; it is not considered as a portion of the mine product, nor is the miner paid for it in wages. Such exceptions are few and the quantity is negligible. The quantity of coal consumed in the manufacture of coke is also considered in this report.

The quantity of coal consumed in the manufacture of coke at the mines in 1909 was 48,677,611 short tons, as compared with 32,228,344 short tons in 1908, an increase of 16,449,267 tons, or 50 per cent. This compares with an increase of 10.8 per cent in the total production, and indicates to what an extent the recovery in the iron trade was responsible for the increased production in 1909. The coal shipped to market, used in the manufacture of coke, and sold locally (which is considered the marketable product), amounted in 1909 to 442,668,210 short tons, compared with 398,642,321 short tons in 1908 and with 462,802,051 tons in 1907. The colliery consumption in the anthracite region, which consists almost altogether of culm, averages from 8 to 10 per cent of the anthracite output. In 1909, out of a total production of 72,374,249 long tons, 7,720,685 tons, or more than 10 per cent, were used at the mines for steam and heat. The colliery consumption of bituminous coal amounts to between 2 and 3 per cent of the total output, and in 1909, out of a total of 379,744,257 tons of bituminous coal mined, 9,488,039 tons were used in the operation of the properties.

PRODUCTION.

STATISTICS FOR 1909.

The statistics of the production of coal in the United States in 1908 and 1909, by States, with the distribution of the product for consumption, are shown in the tables following.

Coal production of the United States in 1908, by States and Territories, in short tons.

State or Territory.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Alabama	8,465,564	136,368	398,341	2,604,320	11,604,593	$14,647,891	$1.26	222	19,197
Arkansas	1,991,188	14,793	72,376	....	2,078,357	3,499,470	1.68	145	5,337
California and Alaska	14,192	3,109	4,561	....	21,862	69,650	3.19	220	49
Colorado	7,786,422	245,493	331,104	1,271,954	9,634,973	13,586,988	1.41	212	14,523
Georgia	184,040	930	8,400	71,452	264,822	364,279	1.38	261	670
Idaho	5,379	50	....	....	5,429	21,832	4.02	160	24
Illinois	43,468,245	2,696,972	1,491,514	2,959	47,659,690	49,978,247	1.05	185	68,035
Indiana	11,371,188	610,410	333,292	....	12,314,890	13,084,297	1.06	174	18,380
Iowa	6,345,590	650,481	165,239	....	7,161,310	11,706,402	1.63	214	16,021
Kansas	5,923,183	154,904	167,024	397	6,245,508	9,292,222	1.49	181	13,916
Kentucky	9,420,514	481,209	260,075	84,755	10,246,553	10,317,162	1.01	186	16,996
Maryland	4,288,306	38,054	50,733	....	4,377,093	5,116,753	1.17	220	6,079
Massachusetts	....	50	....	....	50	150	3.00	....	....
Michigan	1,674,425	87,223	73,371	....	1,835,019	3,322,904	1.81	207	4,247
Missouri	2,927,648	342,953	46,714	....	3,317,315	5,444,907	1.64	169	8,988
Montana	1,679,547	101,846	79,529	59,268	1,920,190	3,771,248	1.96	224	3,146
New Mexico	1,953,851	23,063	40,909	450,114	2,467,937	3,368,753	1.37	197	3,448
North Dakota	187,095	121,286	12,361	....	320,742	522,116	1.63	181	631
Ohio	24,208,224	1,494,630	564,749	3,036	26,270,639	27,897,704	1.06	161	47,407
Oklahoma	2,747,033	47,472	153,611	....	2,948,116	5,976,504	2.03	172	8,651
Oregon	45,375	22,518	18,366	....	86,259	236,021	2.74	249	214
Pennsylvania, bituminous	91,360,007	1,801,292	2,817,237	21,200,991	117,179,527	118,816,303	1.01	201	165,961
Tennessee	5,568,671	93,143	102,715	434,642	6,199,171	7,118,499	1.15	209	11,812
Texas	1,823,640	52,754	18,983	....	1,895,377	3,419,481	1.80	254	4,400
Utah	1,527,165	28,697	61,789	229,141	1,846,792	3,119,338	1.69	227	2,664
Virginia	2,344,308	67,900	110,671	1,736,163	4,259,042	3,868,524	.91	200	6,208
Washington	2,715,920	106,244	134,109	68,670	3,024,943	6,690,412	2.21	202	5,484
West Virginia	36,440,822	641,527	805,012	4,010,482	41,897,843	40,009,054	.95	185	56,861
Wyoming	5,150,298	76,552	263,052	....	5,489,902	8,868,157	1.62	217	6,915
Total bituminous	281,617,840	10,141,923	8,585,837	32,228,344	332,573,944	374,135,268	1.12	193	516,264
Pennsylvania anthracite	72,933,252	1,720,962	8,614,540	....	83,268,754	158,178,849	1.90	200	174,174
Grand total	354,551,092	11,862,885	17,200,377	32,228,344	415,842,698	532,314,117	1.28	195	690,438

Coal production of the United States in 1909, by States and Territories, in short tons.

State or Territory.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of employees.[a]
Alabama	9,466,945	197,032	536,501	3,502,972	13,703,450	$16,306,236	$1.19	17,760
Arkansas	2,270,206	16,048	90,903	....	2,377,157	3,523,139	1.48	5,266
California and Alaska	34,888	6,097	7,651	....	48,636	107,342	2.21	15
Colorado	8,461,976	268,499	329,742	1,656,719	10,716,936	14,296,012	1.33	11,472
Georgia	119,806	1,000	4,100	86,290	211,196	298,792	1.41	460
Idaho	....	4,553	....	....	4,553	19,459	4.27	17
Illinois	46,595,285	2,838,947	1,470,129	629	50,904,990	53,522,014	1.05	69,425
Indiana	13,534,588	861,815	435,356	2,500	14,834,259	15,154,681	1.02	20,937
Iowa	6,836,771	708,415	212,576	....	7,757,762	12,793,628	1.65	17,286
Kansas	6,611,613	222,376	152,062	427	6,986,478	10,083,384	1.44	12,359
Kentucky	9,836,512	511,625	263,480	85,767	10,697,384	10,079,917	.94	16,903
Maryland	3,917,803	55,882	49,556	....	4,023,241	4,471,731	1.11	8,004
Michigan	1,619,221	95,195	70,276	....	1,784,692	3,199,351	1.79	3,496
Missouri	3,244,600	441,543	70,387	....	3,756,530	6,183,626	1.65	9,188
Montana	2,256,161	102,006	112,775	82,998	2,553,940	5,036,942	1.97	4,535
New Mexico	1,991,715	34,706	32,948	741,759	2,801,128	3,619,744	1.29	3,317
North Dakota	257,128	152,132	12,787	....	422,047	645,142	1.53	972
Ohio	25,657,961	1,643,895	636,959	826	27,939,641	27,789,010	.99	38,114
Oklahoma	2,879,114	51,162	189,101	....	3,119,377	6,253,367	2.00	8,689
Oregon	44,236	25,700	17,340	....	87,276	235,085	2.69	235
Pennsylvania, bituminous	98,797,655	2,558,292	2,965,666	33,645,178	137,966,791	130,085,237	.94	159,321
Tennessee	5,634,109	100,891	127,343	496,302	6,358,645	6,920,564	1.09	10,031
Texas	1,770,101	6,362	47,977	....	1,824,440	3,141,945	1.72	4,196
Utah	1,801,934	30,747	100,619	333,599	2,266,899	3,751,810	1.66	3,014
Virginia	2,702,114	53,708	181,815	1,814,580	4,752,217	4,251,056	.89	6,191
Washington	3,302,237	74,700	155,618	69,708	3,602,263	9,158,999	2.54	5,992
West Virginia	43,946,303	812,677	932,883	6,157,357	51,849,220	44,661,716	.86	55,433
Wyoming	6,027,903	83,717	281,489	....	6,393,109	9,896,848	1.55	7,123
Total bituminous	309,618,885	11,959,722	9,488,039	48,677,611	379,744,257	405,486,777	1.07	499,754
Pennsylvania anthracite	70,215,595	2,196,397	8,647,167	....	81,059,159	149,415,847	1.84	166,801
Grand total	379,834,480	14,156,119	18,135,206	48,677,611	460,803,416	554,902,624	1.20	666,555

a Preliminary figures compiled by Bureau of the Census.

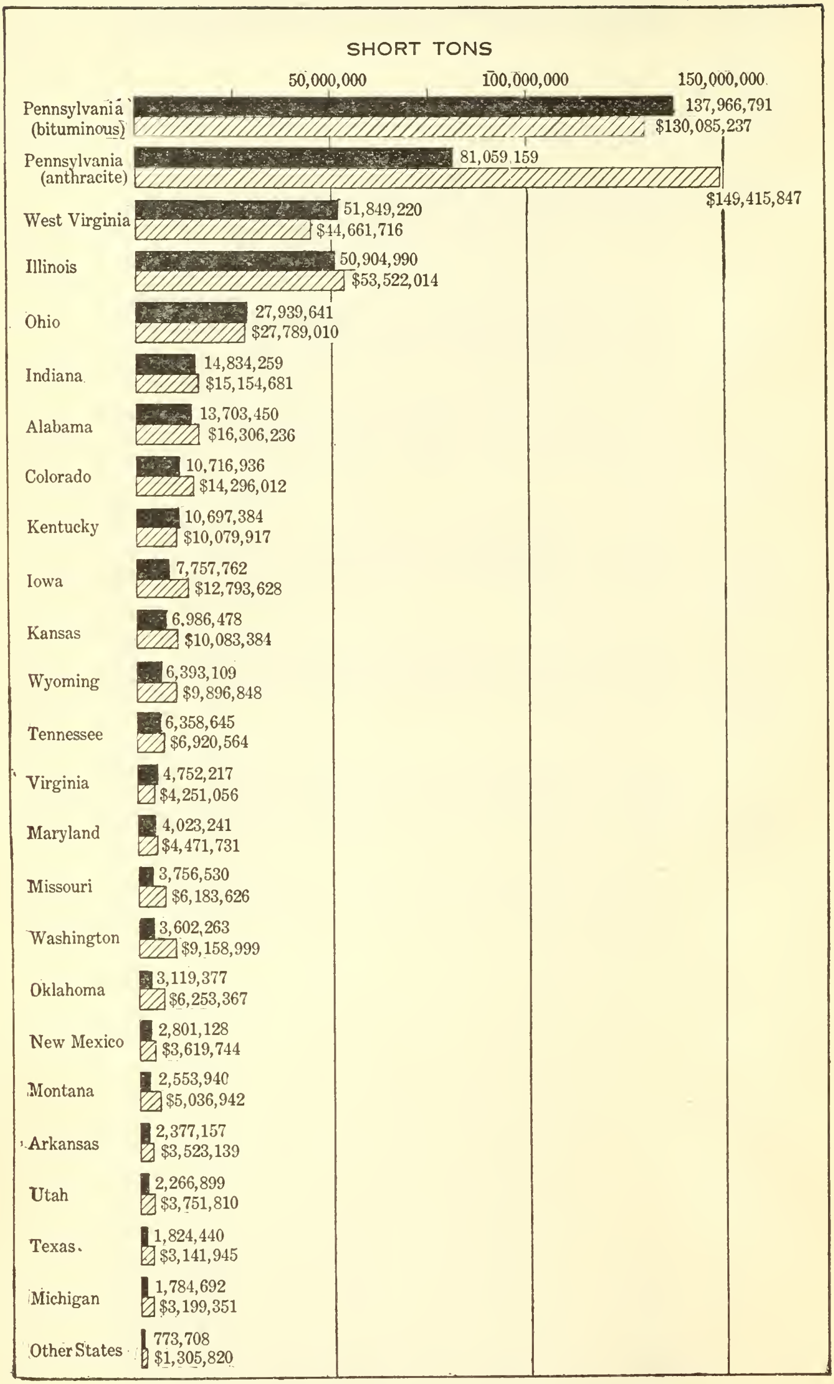

FIGURE 1.—Production of coal in the United States in 1909, by States.

Of the 29 States and Territories in which coal was produced in 1908 and 1909, there were five in which the production in 1909 was less than in 1908. These were Georgia, Idaho, Maryland, Michigan, and Texas. In addition, Massachusetts should be mentioned, from which State a small production (50 tons) of lignite was reported in 1908, but no output was reported in 1909. The total decrease amounted to a little more than 525,000 tons. Nearly 70 per cent of the total decrease was in Maryland, and in that State this was due to the approaching exhaustion of the principal source of supply—the "big vein" of Maryland. A decrease of approximately 71,000 tons in Texas was due to the increased production of oil and natural gas from the Louisiana and mid-Continent fields. Georgia's decrease of 53,626 tons was due chiefly to the shortage of labor, the State having withdrawn its convicts who performed the principal part of the labor. Michigan's decrease of 50,327 tons was caused by the inroads of other coals, chiefly from Ohio and Pennsylvania, into the markets tributary to the Michigan fields.

The principal increases were in bituminous coal in Pennsylvania, which showed a gain of 20,787,264 short tons, or 17.7 per cent; in West Virginia, 9,951,377 tons, or 23.7 per cent; and in Illinois, 3,233,561 short tons, or 6.8 per cent. Alabama's increase, which was principally in the quantity of coal made into coke, was 2,098,857 short tons, or 18.1 per cent. The credit for the largest percentage of increase among the more important producing States goes, first, to West Virginia, and, second, to Indiana, which gained 2,519,369 short tons, or 20.4 per cent. Only two other States showed increase in excess of 1,000,000 tons—namely, Ohio, which gained 1,669,002 short tons, and Colorado, 1,081,963 short tons. Except in very few instances the percentage of gain in value was less than the increase in production, as there was a general falling off in prices all over the country.

The production of Pennsylvania anthracite decreased from 74,347,102 long tons (or 83,268,754 short tons), valued at $158,178,849, in 1908, to 72,374,249 long tons (or 81,059,159 short tons), valued at $149,415,847, in 1909. The total production of bituminous coal increased from 332,573,944 short tons, valued at $374,135,268, in 1908, to 379,744,257 short tons, valued at $405,486,777, in 1909, an increase of 47,170,313 short tons, or 14.2 per cent, in quantity, and of $31,351,509, or 8.4 per cent, in value.

In the following table is presented a statement of the total production and value of coal in the United States in the last five years, by States, with the increases and decreases in 1909 as compared with 1908:

Quantity and value of coal produced in the United States, 1905–1909, in short tons.

State or Territory.	1905		1906	
	Quantity.	Value.	Quantity.	Value.
Alabama	11,866,069	$14,387,721	13,107,963	$17,514,786
Arkansas	1,934,673	2,880,738	1,864,268	3,000,339
California and Alaska	80,824	395,975	30,831	78,684
Colorado	8,826,429	10,810,978	10,111,218	12,735,616
Georgia and North Carolina	353,548	456,184	[a] 332,107	[a] 424,004
Idaho	[b] 5,882	[b] 17,846	[b] 6,165	[b] 24,238
Illinois	38,434,363	40,577,592	41,480,104	44,763,062
Indiana	11,895,252	12,492,255	12,092,560	13,116,261
Indian Territory (Oklahoma)	2,924,427	5,145,358	2,860,200	5,482,366
Iowa	6,798,609	10,586,381	7,266,224	11,619,455
Kansas	6,423,979	9,350,542	6,024,775	8,979,553
Kentucky	8,432,523	8,385,232	9,653,647	9,809,938
Maryland	5,108,539	5,831,760	5,435,453	6,474,793
Massachusetts				
Michigan	1,473,211	2,512,697	1,346,338	2,427,404
Missouri	3,983,378	6,291,661	3,758,008	6,118,733
Montana	1,643,832	2,823,350	1,829,921	3,240,357
New Mexico	1,649,933	2,190,231	1,964,713	2,638,986
North Dakota	317,542	424,778	305,689	451,382
Ohio	25,552,950	26,486,740	27,731,640	30,346,580
Oregon	109,641	282,495	79,731	212,338
Pennsylvania bituminous	118,413,637	113,390,507	129,293,206	130,290,651
Tennessee	5,766,690	6,577,881	6,259,275	7,667,415
Texas	1,200,684	1,968,558	1,312,873	2,178,901
Utah	1,332,372	1,793,510	1,772,551	2,408,381
Virginia	4,275,271	3,777,325	4,254,879	4,183,991
Washington	2,864,926	5,141,258	3,276,184	5,908,434
West Virginia	37,791,580	32,341,790	43,290,350	41,051,939
Wyoming	5,602,021	7,336,951	6,133,994	8,013,528
Total bituminous	315,062,785	334,658,294	342,874,867	381,162,115
Pennsylvania anthracite	77,659,850	141,879,000	71,282,411	131,917,694
Grand total	392,722,635	476,537,294	414,157,278	513,079,809

State or Territory.	1907		1908	
	Quantity.	Value.	Quantity.	Value.
Alabama	14,250,454	$18,405,468	11,604,593	$14,647,891
Arkansas	2,670,438	4,473,693	2,078,357	3,499,470
California and Alaska	24,089	91,813	21,862	69,650
Colorado	10,790,236	15,079,449	9,634,973	13,586,988
Georgia and North Carolina	[a] 362,401	[a] 499,686	264,822	364,279
Idaho	[c] 7,588	[c] 31,119	5,429	21,832
Illinois	51,317,146	54,687,382	47,659,690	49,978,247
Indiana	13,985,713	15,114,300	12,314,890	13,084,297
Iowa	7,574,322	12,258,012	7,161,310	11,706,402
Kansas	7,322,449	11,159,698	6,245,508	9,292,222
Kentucky	10,753,124	11,405,038	10,246,553	10,317,162
Maryland	5,532,628	6,623,697	4,377,093	5,116,753
Massachusetts			50	150
Michigan	2,035,858	3,660,833	1,835,019	3,322,904
Missouri	3,997,936	6,540,709	3,317,315	5,444,907
Montana	2,016,857	3,907,082	1,920,190	3,771,248
New Mexico	2,628,959	3,832,128	2,467,937	3,368,753
North Dakota	347,760	560,199	320,742	522,116
Ohio	32,142,419	35,324,746	26,270,639	27,897,704
Oklahoma (Indian Territory)	3,642,658	7,433,914	2,948,116	5,976,504
Oregon	70,981	166,304	86,259	236,021
Pennsylvania bituminous	150,143,177	155,664,026	117,179,527	118,816,303
Tennessee	6,810,243	8,490,334	6,199,171	7,118,499
Texas	1,648,069	2,778,811	1,895,377	3,419,481
Utah	1,947,607	2,959,769	1,846,792	3,119,338
Virginia	4,710,895	4,807,533	4,259,042	3,868,524
Washington	3,680,532	7,679,801	3,024,943	6,690,412
West Virginia	48,091,583	47,846,630	41,897,843	40,009,054
Wyoming	6,252,990	9,732,668	5,489,902	8,868,157
Total bituminous	394,759,112	451,214,842	332,573,944	374,135,268
Pennsylvania anthracite	85,604,312	163,584,056	83,268,754	158,178,849
Grand total	480,363,424	614,798,898	415,842,698	532,314,117

[a] Georgia only. [b] Includes production of Nevada. [c] Includes production of Nebraska and Nevada.

Quantity and value of coal produced in the United States, 1905–1909, in short tons—Con.

State or Territory.	1909		Increase (+) or decrease (−), 1909.		Percentage of increase or decrease, 1909.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Alabama	13,703,450	$16,306,236	+ 2,098,857	+$1,658,345	+ 18.1	+ 11.3
Arkansas	2,377,157	3,523,139	+ 298,800	+ 23,669	+ 13.9	+ 0.7
California and Alaska	48,636	107,342	+ 26,774	+ 37,692	+122.5	+ 54.1
Colorado	10,716,936	14,296,012	+ 1,081,963	+ 709,024	+ 11.2	+ 5.2
Georgia	211,196	298,792	− 53,626	− 65,487	− 20	− 18
Idaho	4,553	19,459	− 876	− 2,373	− 16.14	− 10.9
Illinois	50,904,990	53,522,014	+ 3,245,300	+ 3,543,767	+ 6.8	+ 7.1
Indiana	14,834,259	15,154,681	+ 2,519,369	+ 2,070,384	+ 20.4	+ 15.8
Iowa	7,757,762	12,793,628	+ 596,452	+ 1,087,226	+ 8.3	+ 9.2
Kansas	6,986,478	10,083,384	+ 740,970	+ 791,162	+ 11.9	+ 8.5
Kentucky	10,697,384	10,079,917	+ 450,831	− 237,245	+ 4.5	− 2.3
Maryland	4,023,241	4,471,731	− 353,852	− 645,022	− 8	− 12.6
Massachusetts	....	....	− 50	− 150	−100.0	−100.0
Michigan	1,784,692	3,199,351	− 50,327	− 123,553	− 2.7	− 3.7
Missouri	3,756,530	6,183,626	+ 439,215	+ 738,719	+ 12.9	+ 13.5
Montana	2,553,940	5,036,942	+ 633,750	+ 1,265,694	+ 33	+ 33.6
New Mexico	2,801,128	3,619,744	+ 333,191	+ 250,991	+ 13.5	+ 7.5
North Dakota	422,047	645,142	+ 101,305	+ 123,026	+ 31.6	+ 23.6
Ohio	27,939,641	27,789,010	+ 1,669,002	− 108,694	+ 4.4	− .4
Oklahoma	3,119,377	6,253,367	+ 171,261	+ 276,863	+ 5.8	+ .94
Oregon	87,276	235,085	+ 1,017	− 936	+ .12	− .04
Pennsylvania bituminous	137,966,791	130,085,237	+20,787,264	+11,268,934	+ 17.7	+ 9.5
Tennessee	6,358,645	6,920,564	+ 159,474	− 197,935	+ 2.57	− 2.78
Texas	1,824,440	3,141,945	− 70,937	− 277,536	− 3.2	− 8.1
Utah	2,266,899	3,751,810	+ 420,107	+ 632,472	+ 22.4	+ 20.3
Virginia	4,752,217	4,251,056	+ 493,175	+ 382,532	+ 11.5	+ 9.9
Washington	3,602,263	9,158,999	+ 577,320	+ 2,468,587	+ 19	+ 37
West Virginia	51,849,220	44,661,716	+ 9,951,377	+ 4,652,662	+ 23.7	+11.6
Wyoming	6,393,109	9,896,848	+ 903,207	+ 1,028,691	+ 16	+11.6
Total bituminous	379,744,257	405,486,777	+47,170,313	+31,351,509	+ 14.2	+ 8.4
Pennsylvania anthracite	81,059,159	149,415,847	− 2,209,595	− 8,763,002	− 2.7	− 5.5
Grand total	460,803,416	554,902,624	+44,960,718	+22,588,507	+ 10.8	+ 4.2

Compared with the phenomenal rapidity with which the production of bituminous coal in the United States has grown during the last quarter of a century, the anthracite industry of Pennsylvania has remained almost stationary. The maximum production of both anthracite and bituminous coal was obtained in 1907, in which year, as shown in the preceding table, the output of anthracite amounted to 85,604,312 short tons; during the four preceding years it averaged a little less than 75,000,000 short tons. From 1891 to 1900 the annual production of anthracite ranged between 50,000,000 and 60,000,000 tons, and it is believed by many who are familiar with the anthracite industry that the maximum production has been reached, although there are some who predict that before the period of decline arrives a total of 100,000,000 long tons (112,000,000 short tons) will be mined. In 1880, according to the Tenth Census, the production of anthracite amounted to 28,649,812 short tons, and in the same year the bituminous production amounted to 42,831,758 short tons. In 1890 the production of anthracite had grown to 41,489,858 long tons, or 46,468,641 short tons, and the bituminous production amounted to 111,302,322 short tons. In 1900 the anthracite output had increased to 51,221,353 long tons (or 57,367,915 short tons), a gain of 23.5 per cent, and the bituminous production had grown to 212,316,112 short tons, or 90.8 per cent. During the next seven years the anthracite production gained 49.2 per cent, rising in 1907 to 76,432,421 long tons (or 85,604,312 short tons), while the bituminous production gained 85.9 per cent, rising in 1907 to 394,759,112 short tons. In 1909 the anthracite output decreased to 72,374,249 long tons (81,059,159 short tons), and the bituminous output to 379,744,257 short tons. The production of anthracite in 1909 included 3,694,470 long tons (or 4,137,806 short tons), most of which was recovered from the old culm banks by washing and was not actually a part of the mine product for that year. It included also 96,239 tons recovered by dredges from the bed of the Susquehanna River.

The accompanying diagram (fig. 2) illustrates the comparative growth of anthracite and bituminous coal from 1856 to 1909. Prior to 1870 the larger production was of Pennsylvania anthracite. Since 1870 the production of bituminous coal has rapidly outstripped that of anthracite. The output of anthracite in 1909 was 72,374,249 long tons (or 81,059,159 short tons), an increase over 1880 of 46,794,060 long tons (52,409,347 short tons), or 183 per cent. The production of bituminous coal in the same time has increased from 42,831,758 short tons to 379,744,257 short tons, an increase of 336,912,499 short tons, or nearly 800 per cent. Anthracite was at one time an important factor in blast-furnace practice, but its use in that line of industry has now almost entirely ceased, having been supplanted by coke made from bituminous coal. The principal demand for anthracite will be in the future, as it has been in the more recent past, restricted largely to domestic trade, for which such sizes as furnace, egg, stove, and chestnut are required. The breaking down of the lump coal, which was formerly a marketable product, for the preparation of the domestic sizes results in a much larger proportion of the small or undesirable sizes, all of which are sold at less than the cost of production. As shown in the subsequent pages of this report, the percentage of these small sizes has increased from 23.1 per cent in 1890 to 41.6 per cent in 1909, while the percentage of sizes above pea coal, or what may be termed the profitable sizes, has decreased from 77 to 58.4 per cent. All of the profits on the mining operations must be obtained from the prepared domestic sizes, for the revenue obtained from the smaller sizes, which are sold largely in competition with bituminous coal for steaming purposes, serves only to reduce the cost of the domestic sizes. The conditions under which the anthracite mines are operated, the greater depths to which the workings are carried, the consequent increased expense of mining, and the increasing cost of labor all contribute to make anthracite fuel more and more a luxury. No hope is held out to the consumer that anthracite will in the future be sold at lower prices than those which prevail to-day; but, on the other hand, there is every reason to believe that prices must advance in accordance with the increasing cost of production. It is only by reason of economical administration that prices are not higher than they are.

During recent years the anthracite operators have adopted the policy of making an allowance of 50 cents per ton from circular prices for domestic coal purchased in April of each year, with an advance of 10 cents per ton for each succeeding month until the schedule prices are restored in September. This has had a more salutary effect in steadying the anthracite trade than any other action taken by those controlling the anthracite industry. Its purpose is to encourage the purchase of coal in the spring and early summer, making

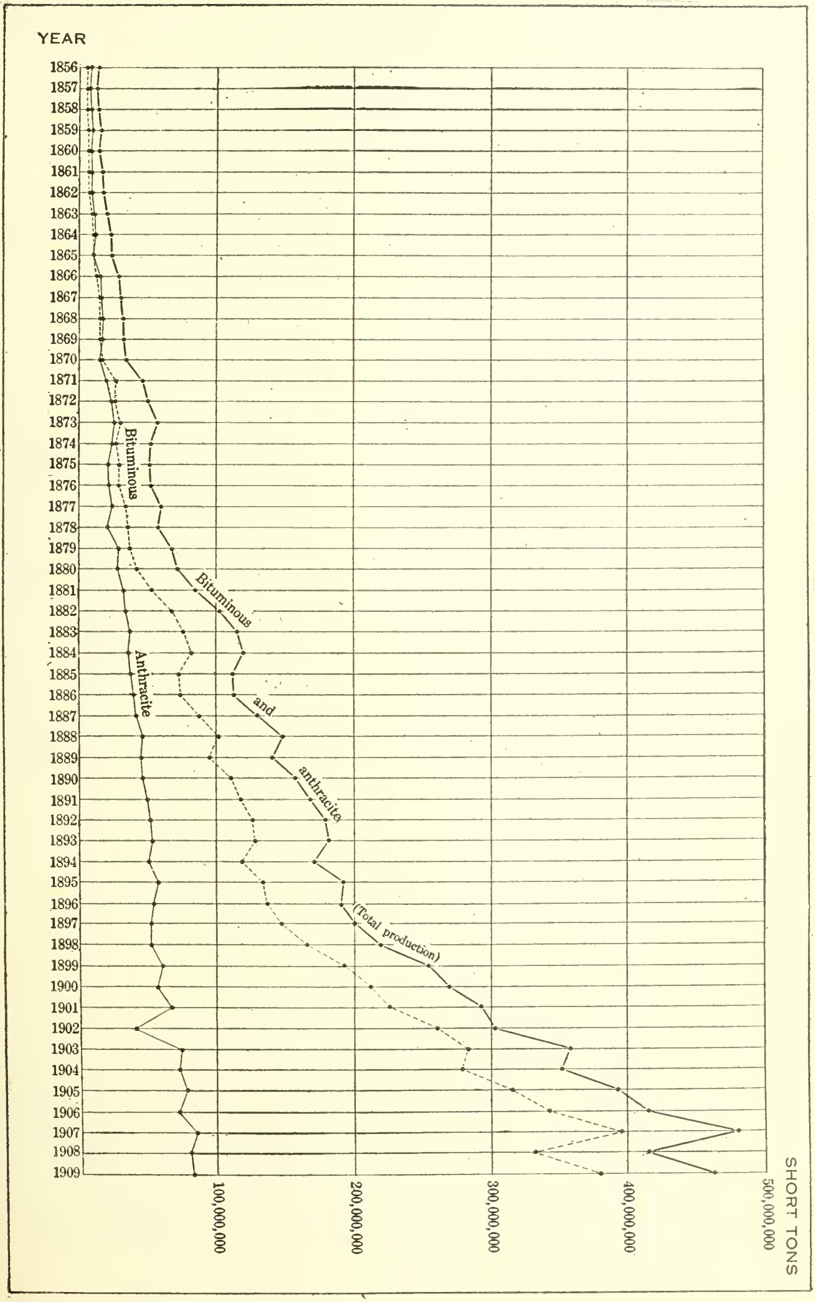

FIGURE 2.—Yearly production of anthracite and bituminous coal from 1856 to 1909, in short tons.

the cellars of the consumers the storage places for the following winter, and at the same time to cause the mines to be operated more regularly, thus giving more steady employment to employees throughout the year.

The statistics covering the distribution of the coal production of the United States for consumption have been obtained only since 1889. These are shown in the following table, by five-year periods since 1890, and annually since 1906:

Distribution of the coal product of the United States, 1890, 1895, 1900, and 1905–1909, in short tons.

Year.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.
1890	128,365,965	9,009,285	5,063,953	15,331,760
1895	158,380,289	9,655,505	6,677,539	18,404,197
1900	223,782,088	9,077,242	9,189,746	27,634,951
1905	324,059,447	12,208,687	14,042,173	42,412,328
1906	341,526,755	11,640,238	14,833,984	46,156,301
1907	399,421,195	13,091,034	17,561,373	50,289,822
1908	354,551,092	11,862,885	17,200,377	32,228,344
1909	379,834,480	14,156,119	18,135,206	48,677,611

Year.	Total product.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
1890	157,770,963	$176,804,573	$1.12	216	318,204
1895	193,117,530	197,799,043	1.02	195	382,879
1900	269,684,027	306,688,164	1.14	212	448,581
1905	392,722,635	476,537,294	1.21	212	626,035
1906	414,157,278	513,079,809	1.24	209	640,780
1907	480,363,424	614,798,898	1.28	231	680,492
1908	415,842,698	532,314,117	1.28	195	690,438
1909	460,803,416	554,902,624	1.20	....	666,555

Production of coal in the United States, 1880, 1885, 1890, 1895, and 1900–1909.

Year.	Pennsylvania anthracite.			Bituminous coal.		
	Quantity.		Value.	Quantity.		Value.
	Long tons.	*Short tons.*		*Long tons.*	*Short tons.*	
1880	25,580,189	28,649,812	$42,196,678	38,242,641	42,831,758	$58,443,718
1885	34,228,548	38,335,974	76,671,948	65,021,715	72,824,321	82,347,648
1890	41,489,858	46,468,641	66,383,772	99,377,073	111,302,322	110,420,801
1895	51,785,122	57,999,337	82,019,272	120,641,244	135,118,193	115,779,771
1900	51,221,353	57,367,915	85,757,851	189,567,957	212,316,112	220,930,313
1901	60,242,560	67,471,667	112,504,020	201,632,276	225,828,149	236,422,049
1902	36,940,710	41,373,595	76,173,586	232,336,468	260,216,844	290,858,483
1903	66,613,454	74,607,068	152,036,448	252,454,775	282,749,348	351,687,933
1904	65,318,490	73,156,709	138,974,020	248,803,293	278,659,689	305,397,001
1905	69,339,152	77,659,850	141,879,000	281,306,058	315,062,785	334,658,294
1906	63,645,010	71,282,411	131,917,694	306,138,274	342,874,867	381,162,115
1907	76,432,421	85,604,312	163,584,056	352,463,493	394,759,112	451,214,842
1908	74,347,102	83,268,754	158,178,849	296,941,021	332,573,944	374,135,268
1909	72,374,249	81,059,159	149,415,847	339,057,372	379,744,257	405,486,777

Production of coal in the United States, 1880, 1885, 1890, 1895, and 1900-1909—Con.

Year.	Total.		
	Quantity.		Value.
	Long tons.	*Short tons.*	
1880	63,822,830	71,481,570	$100,640,396
1885	99,250,263	111,160,295	159,019,596
1890	140,866,931	157,770,963	176,804,573
1895	172,426,366	193,117,530	197,799,043
1900	240,789,310	269,684,027	306,688,164
1901	261,874,836	293,299,816	348,926,069
1902	269,277,178	301,590,439	367,032,069
1903	319,068,229	357,356,416	503,724,381
1904	314,121,783	351,816,398	444,371,021
1905	350,645,210	392,722,635	476,537,294
1906	369,783,284	414,157,278	513,079,809
1907	428,895,914	480,363,424	614,798,898
1908	371,288,123	415,842,698	532,314,117
1909	411,431,621	460,803,416	554,902,624

In the following table is presented a statement showing how the coal production of the five principal States—Pennsylvania, Illinois, West Virginia, Ohio, and Alabama—has grown, relatively to the total production, since 1860. The statistics are for each ten years from 1860 to 1900, and annually from 1901 to 1909, inclusive. It will be observed that Pennsylvania, which produced nearly three-fourths (74 per cent) of the total output of the United States in 1860, has produced less than 50 per cent in each of the last eight years. In 1909 Pennsylvania produced 47.5 per cent of the total. West Virginia, which was not a separate State in 1860, produced less than 2 per cent in 1870, and in 1909 produced 11.2 per cent of the total output. Illinois has more than doubled her percentage, increasing from 5 in 1860 to 11 in 1909. Ohio's percentage has decreased from 8.7 to 6.1, and Alabama, which in 1860 produced less than one-tenth of 1 per cent, has produced approximately 3 per cent since 1890.

Relative production of Pennsylvania, West Virginia, Illinois, Ohio, and Alabama to total output, 1860-1909, in short tons.

Year.	Total production, United States.	Pennsylvania.		West Virginia.	
		Production.	Percentage of total production.	Production.	Percentage of total production.
1860	14,610,042	10,806,628	74.0		
1870	33,035,580	23,462,793	71.0	608,878	1.8
1880	71,481,570	47,074,975	65.9	1,829,844	2.6
1890	157,770,963	88,770,814	56.3	7,394,654	4.7
1900	269,684,027	137,210,241	50.9	22,647,207	8.4
1901	293,299,816	149,777,613	51.1	24,068,402	8.2
1902	301,590,439	139,947,962	46.4	24,570,826	8.1
1903	357,356,416	177,724,246	49.7	29,337,241	8.2
1904	351,816,398	171,094,996	48.6	32,406,752	9.2
1905	392,722,635	196,073,487	49.9	37,791,580	9.6
1906	414,157,278	200,575,617	48.4	43,290,350	10.5
1907	480,363,424	235,747,489	49.1	48,091,583	10.0
1908	415,842,698	200,448,281	48.2	41,897,843	10.1
1909	460,803,416	219,025,950	47.5	51,849,220	11.2

Relative production of Pennsylvania, West Virginia, Illinois, Ohio, and Alabama to total output, 1860–1909, in short tons—Continued.

Year.	Illinois.		Ohio.		Alabama.	
	Production.	Percentage of total production.	Production.	Percentage of total production.	Production.	Percentage of total production.
1860	728,400	5.0	1,265,600	8.7	10,200	0.07
1870	2,624,163	7.9	2,527,285	7.7	11,000	.03
1880	6,115,377	8.6	6,008,595	8.4	323,972	.45
1890	15,292,420	9.7	11,494,506	7.3	4,090,409	2.6
1900	25,767,981	9.6	18,988,150	7.0	8,394,275	3.1
1901	27,331,552	9.3	20,943,807	7.1	9,099,052	3.1
1902	32,939,373	10.9	23,519,894	7.8	10,354,570	3.4
1903	36,957,104	10.3	24,838,103	7.0	11,654,324	3.3
1904	36,475,060	10.4	24,400,220	6.9	11,262,046	3.2
1905	38,434,363	9.8	25,552,950	6.5	11,866,069	3.0
1906	41,480,104	10.0	27,731,640	6.7	13,107,963	3.2
1907	51,317,146	10.7	32,142,419	6.7	14,250,454	3.0
1908	47,659,690	11.5	26,270,639	6.3	11,604,593	2.8
1909	50,904,990	11.0	27,939,641	6.1	13,703,450	3.0

PRODUCTION OF COAL IN THE UNITED STATES FROM THE EARLIEST TIMES TO THE CLOSE OF 1909.

So far as known, the first mention of the occurrence of coal in the United States is made in the journal of Father Hennepin, a French Jesuit missionary, who, in 1679, recorded the site of a "cole mine" on Illinois River, near the present city of Ottawa, Ill. The first actual mining of coal was in the Richmond Basin, Virginia, about seventy years after Father Hennepin's discovery in Illinois, but the first records of production from the Virginia mines were for the year 1822, when, according to one authority, 54,000 tons were mined. Ohio probably ranks second in priority of production, as coal was discovered there in 1755, but the records of production date back only to 1838. The mining of anthracite in Pennsylvania began about 1790, and it is said that in 1807 55 tons were shipped to Columbia, Pa. Reports of the anthracite coal trade are usually begun with the year 1820, when 365 long tons, 1 ton for each day of the year, were shipped to Philadelphia from the Lehigh region. Prior to this, however, in 1814, a shipment of 22 tons was made from Carbondale, also to Philadelphia, and in the following table the production is considered to have begun in that year. It is probable that the actual production prior to 1820 was between 2,500 and 3,000 tons.

In the following table is presented a statement of the total production of anthracite in Pennsylvania since 1814 and of bituminous coal since 1820, and the total annual production to the close of 1909. During the period covered by this table the total production of anthracite in Pennsylvania has amounted to 2,095,838,234 short tons, and the bituminous coal to 5,645,905,447 short tons, indicating that of the total output 27 per cent has been from the anthracite mines of Pennsylvania and 73 per cent has been bituminous coal.

The annual production of each State, from the time of earliest record to the close of 1909, is given in connection with the discussion of the production in the respective States.

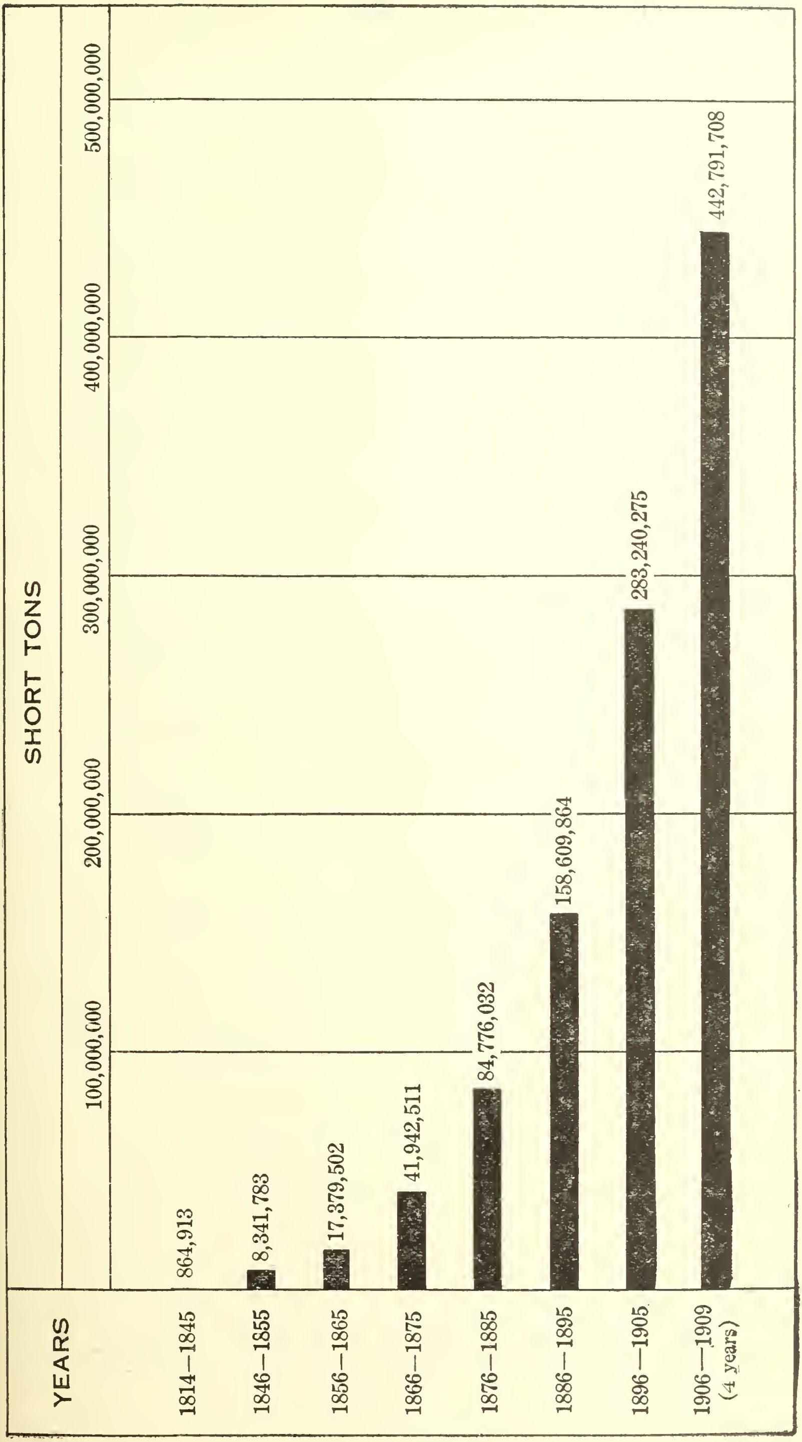

FIGURE 3.—Average yearly production of coal for each decade in the United States since 1814, in short tons.

Production of coal in the United States from 1814 to the close of 1909, in short tons.

Year.	Pennsylvania anthracite.	Bituminous.	Total.
1814	22	....	22
1815	50	....	50
1816	75	....	75
1817	100	....	100
1818	200	....	200
1819	350	....	350
1820	450	3,000	3,450
1821	1,322	....	1,322
1822	4,583	54,000	58,583
1823	8,563	60,000	68,563
1824	13,685	67,040	80,725
1825	42,988	75,000	117,988
1826	59,194	88,720	147,914
1827	78,151	94,000	172,151
1828	95,500	100,408	195,908
1829	138,086	102,000	240,086
1830	215,272	104,800	320,072
1831	217,842	120,100	337,942
1832	447,550	146,500	594,050
1833	600,907	133,750	734,657
1834	464,015	136,500	600,515
1835	690,854	134,000	824,854
1836	842,832	142,000	984,832
1837	1,071,151	182,500	1,253,651
1838	910,075	445,452	1,355,527
1839	1,008,322	552,038	1,560,360
1840	967,108	1,102,931	2,070,039
1841	1,182,441	1,108,700	2,291,141
1842	1,365,563	1,244,494	2,610,057
1843	1,556,753	1,504,121	3,060,874
1844	2,009,207	1,672,045	3,681,252
1845	2,480,032	1,829,872	4,309,904
1846	2,887,815	1,977,707	4,865,522
1847	3,551,005	1,735,062	5,286,067
1848	3,805,942	1,968,032	5,773,974
1849	3,995,334	2,453,497	6,448,831
1850	4,138,164	2,880,017	7,018,181
1851	5,481,065	3,253,460	8,734,525
1852	6,151,957	3,664,707	9,816,664
1853	6,400,426	4,169,862	10,570,288
1854	7,394,875	4,582,227	11,977,102
1855	8,141,754	4,784,919	12,926,673
1856	8,534,779	5,012,146	13,546,925
1857	8,186,567	5,153,622	13,340,189
1858	8,426,102	5,548,376	13,974,478
1859	9,619,771	6,013,404	15,633,175
1860	8,115,842	6,494,200	14,610,042
1861	9,799,654	6,688,358	16,488,012
1862	9,695,110	7,790,725	17,485,835
1863	11,785,320	9,533,742	21,319,062
1864	12,538,649	11,066,474	23,605,123
1865	11,891,746	11,900,427	23,792,173
1866	15,651,183	13,352,400	29,003,583
1867	16,002,109	14,722,313	30,724,422
1868	17,003,405	15,858,555	32,861,960
1869	17,083,134	15,821,226	32,904,360
1870	15,664,275	17,371,305	33,035,580
1871	19,342,057	27,543,023	46,885,080
1872	24,233,166	27,220,233	51,453,399
1873	26,152,837	31,449,643	57,602,480
1874	24,818,790	27,787,130	52,605,920
1875	22,485,766	29,862,554	52,348,320
1876	22,793,245	30,486,755	53,280,000
1877	25,660,316	34,841,444	60,501,760
1878	21,689,682	36,245,918	57,935,600
1879	30,207,793	37,898,006	68,105,799
1880	28,649,812	42,831,758	71,481,570
1881	31,920,018	53,961,012	85,881,030
1882	35,121,256	68,429,933	103,551,189
1883	38,456,845	77,250,680	115,707,525
1884	37,156,847	82,998,704	120,155,551
1885	38,335,974	72,824,321	111,160,295
1886	39,035,446	74,644,981	113,680,427
1887	42,088,197	88,562,314	130,650,511
1888	46,619,564	102,040,093	148,659,657
1889	45,546,970	95,682,543	141,229,513
1890	46,468,641	111,302,322	157,770,963
1891	50,665,431	117,901,238	168,566,669
1892	52,472,504	126,856,567	179,329,071
1893	53,967,543	128,385,231	182,352,774
1894	51,921,121	118,820,405	170,741,526
1895	57,999,337	135,118,193	193,117,530
1896	54,346,081	137,640,276	191,986,357
1897	52,611,680	147,617,519	200,229,199
1898	53,382,644	166,593,623	219,976,267
1899	60,418,005	193,323,187	253,741,192
1900	57,367,915	212,316,112	269,684,027
1901	67,471,667	225,828,149	293,299,816
1902	41,373,595	260,216,844	301,590,439
1903	74,607,068	282,749,348	357,356,416
1904	73,156,709	278,659,689	351,816,398
1905	77,659,850	315,062,785	392,722,635
1906	71,282,411	342,874,867	414,157,278
1907	85,604,312	394,759,112	480,363,424
1908	83,268,754	332,573,944	415,842,698
1909	81,059,159	379,744,257	460,803,416
	2,095,838,234	5,645,905,447	7,741,743,681

COAL FIELDS OF THE UNITED STATES.

The coal areas of the United States are divided, for the sake of convenience, into two great divisions—anthracite and bituminous.

The areas in which anthracite is produced are confined almost exclusively to the eastern part of Pennsylvania, and usually when the anthracite fields of the United States are referred to those of eastern Pennsylvania are meant. These fields are included in the counties of Susquehanna, Lackawanna, Luzerne, Carbon, Schuylkill, Columbia, Northumberland, Dauphin, and Sullivan, and underlie an area of about 480 square miles. In addition to these well-known anthracite fields of Pennsylvania there are two small areas in the Rocky Mountain region where the coal has been locally anthracited, although the production from these districts has never amounted to as much as 100,000 tons in any one year. One of these localities is in Gunnison County, Colo., and the other in Santa Fe County, N. Mex. The coal, although only locally metamorphosed, is a true anthracite and of a good quality. In previous years some coal, which was classed as anthracite, was mined and sold in New England. The productive area was confined to the eastern part of Rhode Island and the counties of Bristol and Plymouth in Massachusetts. In 1909 redevelopment of the old mines at Portsmouth was in progress, and the result of rehabilitating these properties and of utilizing the product will be watched with interest.

The bituminous and lignite fields are scattered widely over the United States and include an area of something over 496,000 square miles. The previous classification of these coal areas as published in earlier volumes of the report, Mineral Resources of the United States, has been changed as a result of conferences among the geologists working under Marius R. Campbell on the economic geology of coal. The areas are divided, primarily, into six provinces, as follows:

(1) The eastern province, which includes all of the bituminous areas of the Appalachian region; the Atlantic coast region, which includes the Triassic fields near Richmond and Deep River and Dan River fields of North Carolina, and also the anthracite region of Pennsylvania. (2) The Gulf province, which includes the lignite fields of Alabama, Mississippi, Louisiana, Arkansas, and Texas. (3) The interior province, which includes all the bituminous areas of the Mississippi Valley region and the coal fields of Michigan. This province is subdivided into the eastern region, which embraces the coal fields of Illinois, Indiana, and western Kentucky; the western region, which includes the fields of Iowa, Missouri, Nebraska, Kansas, Arkansas, and Oklahoma; and the southwestern region, which includes the coal fields of Texas. The Michigan fields are designated as the northern region of the interior province. (4) The northern, or Great Plains, province, which includes the lignite areas of North Dakota and South Dakota and the bituminous and subbituminous areas of northeastern Wyoming and of northern and eastern Montana. (5) The Rocky Mountain province, which includes the coal fields of the portions of Montana and Wyoming which are in the mountainous districts of those States, and all the coal fields of Utah, Colorado, and New Mexico. (6) The Pacific coast province, which includes all of the coal fields of California, Oregon, and Washington.

A map of the coal fields of the United States, prepared by M. R. Campbell, was published in the report, Mineral Resources of the United States, 1907. Copies of the report on the production of coal in 1907, with the accompanying map, may be obtained upon application to the Director of the United States Geological Survey. This map contains a statement covering the character and the geologic age of the coals, and an estimated tonnage of the various fields. The estimates of tonnage have been slightly revised from more recently collated data. The revised estimates place the total original coal supply of the United States at 3,076,204,000,000 short tons, of which 1,922,979,000,000 short tons are considered to be easily accessible, and 1,153,225,000,000 short tons accessible with difficulty. Classified by the character of the coal, the original supply consisted of 21,000,000,000 short tons of anthracite, 1,661,457,000,000 tons of bituminous coal, 650,157,000,000 tons of subbituminous coal, and 743,590,000,000 tons of lignite. The total production of coal in the United States at the close of 1909 was 7,741,743,681 short tons, which, including the waste involved in the mining and preparation, represented an exhaustion of 12,603,671,000 tons, leaving as the apparent supply still available 3,063,600,329,000 tons, or 99.6 per cent of the original supply; that is to say, up to the beginning of 1910 only 0.4 of 1 per cent of the original supply of coal has been exhausted. The quantity of coal still available at the close of 1909 was 6,648 times the production in that year, and 4,432 times the exhaustion represented by that production.

In the following table a statement is given showing the area known to contain coal in the various States, by fields, the estimated original supply, the total production of each State and field in 1909, the total production in each to the close of 1909, and the estimated supply still available.

Coal fields of the United States and their production in 1909.

	Area.[a]	Estimated original contents.	Production in 1909.	Total production to close of 1909.	Total exhaustion to close of 1909.	Estimated available supply.
ANTHRACITE.	*Square miles.*	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*	*Shortt ons.*
Pennsylvania	480	21,000,000,000	81,059,159	2,095,838,234	4,192,000,000	16,808,000,000
Colorado and New Mexico	29	(b)	(b)	(b)	(b)	(b)
Total	509	21,000,000,000	81,059,159	2,095,838,234	4,192,000,000	16,808,000,000
BITUMINOUS.[c]						
Eastern province.						
Atlantic coast region:						
Virginia	150	(d)	(d)	(d)	(d)	(d)
North Carolina	60	200,000,000	....	476,805	715,000	199,285,000
Appalachian region:						
Pennsylvania	14,200	112,574,000,000	137,966,791	2,101,215,571	3,152,000,000	109,422,000,000
Ohio	12,660	86,028,000,000	27,939,641	546,979,638	820,000,000	85,208,000,000
Maryland	455	8,044,000,000	4,023,241	156,006,882	234,000,000	7,810,000,000
Virginia	1,750	22,500,000,000	4,752,217	66,240,411	99,000,000	22,401,000,000
West Virginia	17,000	150,000,000,000	51,849,220	527,945,602	792,000,000	149,208,000,000
Eastern Kentucky	10,270	67,787,000,000	4,826,099	60,539,572	91,000,000	67,696,000,000
Tennessee	4,400	25,665,000,000	6,358,645	96,862,417	145,000,000	25,520,000,000
Georgia	167	933,000,000	211,196	8,599,714	13,000,000	920,000,000
Alabama	8,430	68,903,000,000	13,703,450	190,042,353	285,000,000	68,618,000,000
Total	69,332	542,434,000,000	251,630,500	3,754,432,160	5,631,000,000	536,803,000,000
Interior province.						
Northern region:						
Michigan	11,000	12,000,000,000	1,784,692	17,462,654	26,000,000	11,974,000,000
Eastern region:						
Indiana	6,500	44,169,000,000	14,834,259	186,589,539	280,000,000	43,889,000,000
Western Kentucky	6,400	36,241,000,000	5,871,285	82,808,939	124,000,000	36,117,000,000
Illinois	35,600	240,000,000,000	50,904,990	744,432,989	1,117,000,000	238,883,000,000
Total	48,500	320,410,000,000	71,598,795	1,013,819,728	1,521,000,000	318,889,000,000

[a] Known to contain workable coal.
[b] Included in Rocky Mountain and northern Great Plains provinces.
[c] Includes brown coal or lignite, semianthracite, semibituminous, etc., and scattering lots of anthracite.
[d] Included in Appalachian region.

Coal fields of the United States and their production in 1909—Continued.

	Area.	Estimated original contents.	Production in 1909.	Total production to close of 1909.	Total exhaustion to close of 1909.	Estimated available supply.
BITUMINOUS—continued.						
Interior province—Continued.						
Western and southwestern regions:[a]	*Square miles.*	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*
Iowa	12,560	29,160,000,000	7,757,762	156,527,864	235,000,000	28,925,000,000
Missouri	16,700	40,000,000,000	3,756,530	104,691,951	157,000,000	39,843,000,000
Kansas	3,100	7,022,000,000	6,986,478	104,408,190	157,000,000	6,865,000,000
Arkansas	1,684	1,887,000,000	2,377,157	28,211,915	42,000,000	1,845,000,000
Oklahoma	10,000	79,278,000,000	3,119,377	45,912,508	69,000,000	79,209,000
Texas	10,200	31,000,000,000	1,824,440	18,164,765	27,000,000	30,973,000,000
Total	54,244	188,347,000,000	25,821,744	457,917,193	687,000,000	187,660,000,000
Rocky Mountain and northern Great Plains provinces.						
Arizona	30	60,000,000				60,000,000
North Dakota	31,240	500,000,000,000	422,207	3,527,047	5,000,000	499,995,000,000
Montana	34,067	303,060,000,000	2,553,940	29,213,263	44,000,000	303,016,000,000
South Dakota	2,000	10,000,000,000				10,000,000,000
Wyoming	20,568	424,085,000,000	6,393,109	89,701,776	135,000,000	423,950,000,000
Utah	13,130	196,458,000,000	2,266,899	22,950,873	35,000,000	196,423,000,000
Colorado	10,105	371,770,000,000	10,716,936	133,020,245	200,000,000	371,570,000,000
New Mexico	13,331	163,780,000,000	2,801,128	27,594,497	41,400,000	163,738,600,000
Idaho	200	600,000,000	4,553	37,247	56,000	599,944,000
Total	124,671	1,969,813,000,000	25,158,772	304,044,948	460,456,000	1,969,352,544,000
Pacific coast province and Alaska.						
Washington	1,100	20,000,000,000	3,602,263	49,735,903	75,000,000	19,925,000,000
Oregon	230	1,000,000,000	87,276	1,963,927	3,000,000	997,000,000
California	500	1,000,000,000	45,836	5,095,536	7,500,000	992,500,000
Alaska						
Total	1,830	22,000,000,000	3,735,375	56,795,366	85,500,000	21,914,500,000
Total production, including colliery consumption	[b] 310,296	3,076,204,000,000	460,803,416	[c] 7,741,743,681	12,603,671,000	3,063,600,329,000

[a] Including Texas lignite fields of Gulf province.

[b] Not including 160,705 square miles of which little is known but which may contain workable coals, and 31,805 square miles where coal lies under heavy cover and is not at present available.

[c] Includes 38,901,440 short tons of production between 1871 and 1888, principally colliery consumption, which was not included in the distribution by States.

In the following table are the statistics of the production of each of the various regions from 1887 to the close of 1909:

Total production of each region, 1887–1909, in short tons.

	Anthracite.	Bituminous.		
		Atlantic coast.	Appalachian.	Northern.
Area [a] ... square miles	[b] 519	210	69,332	11,000
Year.				
1887	39,548,255	30,000	55,888,088	71,461
1888	43,971,688	33,000	60,966,245	81,407
1889	45,600,487	49,633	62,972,222	67,431
1890	46,468,641	29,608	73,008,102	74,977
1891	50,665,931	37,645	77,984,563	80,307
1892	52,537,467	43,889	83,122,190	77,990
1893	54,061,121	36,878	81,207,168	45,979
1894	51,992,671	68,979	76,278,748	70,002
1895	58,066,516	82,682	90,167,596	112,322
1896	54,425,573	103,483	90,748,305	92,882
1897	52,680,756	116,950	97,128,220	223,592
1898	53,429,739	38,938	114,239,156	315,722
1899	60,514,201	28,353	129,843,906	624,708
1900	57,466,319	57,912	142,298,208	849,475
1901	67,538,536	12,000	150,501,214	1,241,241
1902	41,467,532	39,206	173,274,861	964,718
1903	74,679,799	35,393	185,600,161	1,367,619
1904	73,228,783	9,100	182,606,561	1,342,840
1905	77,734,673	1,557	212,633,324	1,473,211
1906	71,342,659	....	233,473,524	1,346,338
1907	85,666,404	....	266,501,527	2,035,858
1908	83,310,412	....	216,499,163	1,835,019
1909	81,059,159	....	251,630,500	1,784,692

	Bituminous.			
	Eastern.	Western and Southwestern.	Rocky Mountain, etc.	Pacific coast and Alaska.
Area [a] ... square miles	48,500	54,244	124,671	1,830
Year.				
1887	14,478,883	10,172,634	3,646,280	854,308
1888	19,173,167	11,842,764	4,583,719	1,385,750
1889	16,240,314	10,036,356	5,048,413	1,214,757
1890	20,075,840	10,470,439	6,205,782	1,435,914
1891	20,327,323	11,023,817	7,245,707	1,201,376
1892	23,001,653	11,635,185	7,577,422	1,333,266
1893	25,502,809	11,651,296	8,468,360	1,379,163
1894	22,430,617	11,503,623	7,175,628	1,221,238
1895	23,599,469	11,749,803	7,998,594	1,340,548
1896	25,539,867	11,759,966	7,925,280	1,391,001
1897	26,414,127	13,164,059	8,854,182	1,641,779
1898	25,816,874	13,988,436	10,042,759	2,104,643
1899	33,181,247	15,320,373	11,949,463	2,278,941
1900	35,358,164	17,549,528	13,398,556	2,705,865
1901	37,450,871	19,665,985	14,090,362	2,799,607
1902	46,133,024	20,727,495	16,149,545	2,834,058
1903	52,130,856	23,171,692	16,981,059	3,389,837
1904	51,682,313	23,273,482	16,344,516	3,328,803
1905	55,255,541	23,265,750	19,303,188	3,055,391
1906	59,457,660	23,086,348	22,064,003	3,386,746
1907	71,598,256	26,856,622	23,929,155	3,775,602
1908	65,774,700	23,645,983	21,644,307	3,133,064
1909	71,598,795	25,821,744	25,158,772	3,735,375

[a] Known to contain workable coal.
[b] Includes 29 square miles in Colorado and New Mexico.

The following table shows how the production in the six principal bituminous areas has developed since 1887, and how the percentages of the total produced by each during the last five years compare with one another. The production in the northern region of Michigan shows the largest percentage of increase in the period since 1887, and the percentage of the total contributed by the Pacific coast has decreased:

Production of the six principal bituminous coal regions in 1887, 1905, 1906, 1907, 1908, and 1909, compared, in short tons.

Region.	1887		1905		1906		1907	
	Quantity.	Percentage of total.	Quantity.	Percentage of total.	Quantity.	Percentage of total.	Quantity.	Percentage of total.
Appalachian	55,888,088	63.11	212,633,324	67.49	233,473,524	68.10	266,501,527	67.51
Eastern	14,478,883	16.50	55,255,541	17.54	59,457,660	17.34	71,598,256	18.13
Western	10,172,634	11.49	23,265,750	7.38	23,086,348	6.73	26,856,622	6.80
Northern	71,461	.08	1,473,211	.47	1,346,338	.39	2,035,858	.52
Rocky Mountain	3,646,280	4.15	19,303,188	6.13	22,064,003	6.44	23,929,155	6.06
Pacific coast	854,308	1.00	3,055,391	.97	3,386,746	.99	3,775,602	.96

Region.	1908		1909		Increase in 1909 over 1887.		Increase in 1909 from 1908.	
	Quantity.	Percentage of total.	Quantity.	Percentage of total.	Quantity.	Percentage.	Quantity.	Percentage.
Appalachian	216,499,163	65.10	251,630,500	66.26	195,742,412	350.24	35,131,337	16.23
Eastern	65,774,700	19.78	71,598,795	18.85	57,119,912	394.50	5,824,095	8.85
Western	23,645,983	7.11	25,821,744	6.80	15,649,110	153.84	2,175,761	9.20
Northern	1,835,019	.55	1,784,692	.47	1,713,231	2,397.43	*a* 50,327	*a* 2.74
Rocky Mountain	21,644,307	6.51	25,158,772	6.63	21,512,492	589.98	3,514,465	16.24
Pacific coast	3,133,064	.94	3,735,375	.98	2,881,067	337.24	602,311	19.22

a Decrease.

RANK OF COAL-PRODUCING STATES.

In the following tables the coal-producing States are arranged according to their rank in 1908 and 1909, first in the quantity of coal produced, and then according to the value of the product, with the percentage of both quantity and value contributed by each State. If the production of either anthracite or bituminous coal in Pennsylvania were considered, that State would still remain well in advance of all others individually in the output of coal. In 1909 the production of anthracite alone in Pennsylvania exceeded by more than 50 per cent the total production of West Virginia, which ranked second in coal-producing importance; and the production of bituminous coal alone in Pennsylvania was more than two and a half times that of West Virginia, and also more than the combined production of West Virginia, Illinois, and Ohio, which ranked respectively, second, third, and fourth. In the total production of anthracite and bituminous coal Pennsylvania annually produces nearly 50 per cent of the total coal tonnage of the United States, and exceeds the total output of any European country, with the exception of Great Britain and Germany. Prior to 1902, Pennsylvania yielded more than 50 per cent of the total coal produced in the United States, and has only fallen from this high estate by reason of the industrial progress in the Southern and Western States, which have developed their coal resources in greater ratio than mining has increased in Pennsylvania. The smaller proportion of the total produced by Pennsylvania is not due to any decrease in production in that State. The total production of Pennsylvania increased from 149,777,613 short tons in 1901 to 219,025,950 short tons in 1909, while the production of the States outside of Pennsylvania was increasing from 143,522,203 short tons in 1901 to 241,777,466 short tons in 1909. In the production of bituminous coal Pennsylvania has nearly kept pace with the developments in other sections, but as the production of anthracite has remained practically stationary for several years the State has relatively fallen behind. The most important change in the positions of the several States was the supplanting of Illinois by West Virginia as second State in coal-producing importance, as far as quantity is concerned. This is the second time in the history of the coal-mining industry in the United States that West Virginia has appeared as the second in rank among the coal-producing States, the former occasion being in 1906, when the production of Illinois was materially reduced by labor troubles. In 1909, however, there was no such cause to be assigned for the change in position. The production in West Virginia was pushed with energy, and new markets were secured both east and west. Shipments to the Atlantic seaboard were increased through the additional transportation afforded by the Virginian Railway, and additional facilities for reaching the lake ports helped the western shipments. It is to be noted, however, that in the value of the product Illinois still maintains a strong lead over West Virginia, and in this regard holds second place. The reason for this lies in the fact that the output of Illinois is consumed chiefly within the borders of the State, or within contiguous territory. The production of West Virginia, on the other hand, is almost entirely shipped from the State for the support of manufacturing industries in other portions of the country. The principal consumption of coal in West Virginia is by the locomotives transporting the product from the mines.

Ohio continues to hold fourth place among the coal-producing States, with Indiana fifth and Alabama sixth. Colorado resupplanted Kentucky as the seventh State in rank in 1909, Kentucky having taken Colorado's place in 1908.

Rank of coal-producing States in 1908 and 1909, with quantity and value of product and percentage of each.

1908.

Production.				Value.			
Rank.	State or Territory.	Quantity (short tons).	Percentage of total production.	Rank.	State or Territory.	Value.	Percentage of total value.
1	Pennsylvania:			1	Pennsylvania:		
	Anthracite	83,268,754	20.0		Anthracite	$158,178,849	29.7
	Bituminous	117,179,527	28.2		Bituminous	118,816,303	22.3
2	Illinois	47,659,690	11.5	2	Illinois	49,978,247	9.4
3	West Virginia	41,897,843	10.1	3	West Virginia	40,009,054	7.5
4	Ohio	26,270,639	6.3	4	Ohio	27,897,704	5.2
5	Indiana	12,314,890	3.0	5	Alabama	14,647,891	2.8
6	Alabama	11,604,593	2.8	6	Colorado	13,586,988	2.6
7	Kentucky	10,246,553	2.5	7	Indiana	13,084,297	2.5
8	Colorado	9,634,973	2.3	8	Iowa	11,706,402	2.2
9	Iowa	7,161,310	1.7	9	Kentucky	10,317,162	1.9
10	Kansas	6,245,508	1.5	10	Kansas	9,292,222	1.7
11	Tennessee	6,199,171	1.5	11	Wyoming	8,868,157	1.7
12	Wyoming	5,489,902	1.3	12	Tennessee	7,118,499	1.3
13	Maryland	4,377,093	1.0	13	Washington	6,690,412	1.3
14	Virginia	4,259,042	1.0	14	Oklahoma	5,976,504	1.1
15	Missouri	3,317,315	.8	15	Missouri	5,444,907	1.0
16	Washington	3,024,943	.7	16	Maryland	5,116,753	1.0
17	Oklahoma	2,948,116	.7	17	Virginia	3,868,524	.7
18	New Mexico	2,467,937	.6	18	Montana	3,771,248	.7
19	Arkansas	2,078,357	.5	19	Arkansas	3,499,470	.7
20	Montana	1,920,190	.5	20	Texas	3,419,481	.6
21	Texas	1,895,377	.5	21	New Mexico	3,368,753	.6
22	Utah	1,846,792	.4	22	Michigan	3,322,904	.6
23	Michigan	1,835,019	.4	23	Utah	3,119,338	.6
24	North Dakota	320,742	.1	24	North Dakota	522,116	.1
25	Georgia	264,822		25	Georgia	364,279	.1
26	Oregon	86,259		26	Oregon	236,021	
27	California and Alaska	21,862	.1	27	California and Alaska	69,650	.1
28	Idaho	5,429		28	Idaho	21,832	
29	Massachusetts	50		29	Massachusetts	150	
	Total	415,842,698	100.0		Total	532,314,117	100.0

1909.

Rank.	State or Territory.	Quantity (short tons).	Percentage of total production.	Rank.	State or Territory.	Value.	Percentage of total value.
1	Pennsylvania:			1	Pennsylvania:		
	Anthracite	81,059,159	17.6		Anthracite	$149,415,847	26.9
	Bituminous	137,966,791	29.9		Bituminous	130,085,237	23.4
2	West Virginia	51,849,220	11.2	2	Illinois	53,522,014	9.6
3	Illinois	50,904,990	11.0	3	West Virginia	44,661,716	8.1
4	Ohio	27,939,641	6.1	4	Ohio	27,789,010	5.0
5	Indiana	14,834,259	3.2	5	Alabama	16,306,236	2.9
6	Alabama	13,703,450	3.0	6	Indiana	15,154,681	2.7
7	Colorado	10,716,936	2.3	7	Colorado	14,296,012	2.6
8	Kentucky	10,697,384	2.3	8	Iowa	12,793,628	2.3
9	Iowa	7,757,762	1.7	9	Kansas	10,083,384	1.8
10	Kansas	6,986,478	1.5	10	Kentucky	10,079,917	1.8
11	Wyoming	6,393,109	1.4	11	Wyoming	9,896,848	1.8
12	Tennessee	6,358,645	1.4	12	Washington	9,158,999	1.7
13	Virginia	4,752,217	1.0	13	Tennessee	6,920,564	1.2
14	Maryland	4,023,241	.9	14	Oklahoma	6,253,367	1.1
15	Missouri	3,756,530	.8	15	Missouri	6,183,626	1.1
16	Washington	3,602,263	.8	16	Montana	5,036,942	.9
17	Oklahoma	3,119,377	.7	17	Maryland	4,471,731	.8
18	New Mexico	2,801,128	.6	18	Virginia	4,251,056	.8
19	Montana	2,553,940	.6	19	Utah	3,751,810	.7
20	Arkansas	2,377,157	.5	20	New Mexico	3,619,744	.7
21	Utah	2,266,899	.5	21	Arkansas	3,523,139	.6
22	Texas	1,824,440	.4	22	Michigan	3,199,351	.6
23	Michigan	1,784,692	.4	23	Texas	3,141,945	.6
24	North Dakota	422,047	.1	24	North Dakota	645,142	.1
25	Georgia	211,196		25	Georgia	298,792	.1
26	Oregon	87,276		26	Oregon	235,085	
27	California and Alaska	48,636	.1	27	California and Alaska	107,342	.1
28	Idaho	4,553		28	Idaho	19,459	
	Total	460,803,416	100.0		Total	554,902,624	100.0

KINDS OF COAL PRODUCED IN THE UNITED STATES.

In the general discussion of the coal production of the United States only two divisions are considered, anthracite and bituminous, the latter product including the small anthracite output of Colorado and New Mexico. In the bituminous production, however, in addition to the small Rocky Mountain output of anthracite, is also included the production of coals generally classed as semianthracite, semibituminous, cannel, block, splint, and lignite or subbituminous. In the following tables the production of these varieties of coal in 1908 and 1909 is reported as prepared from the schedules returned to the Geological Survey. It should be stated, however, that this classification makes no claim to technical exactness. It has been compiled from the replies of the producers to the inquiry "Kind of coal produced" on the schedules, and such replies are in some minor cases based on quite uncertain knowledge. It is believed, however, that in this classification the quantity of each kind of coal produced is approximately indicated. It is sufficiently correct for practical purposes and shows that in 1909, in addition to the production of anthracite in Pennsylvania, there were 21,999 tons of anthracite mined in New Mexico and 55,701 tons in Colorado. The semianthracite production is principally from Arkansas, about one-third of the output of that State being classed as semianthracite. Smaller quantities of semianthracite are also produced in Oklahoma and Virginia. The semianthracite production of the Bernice Basin in Pennsylvania has been included in that of anthracite. Semibituminous coal was produced in 16 States in both 1908 and 1909. Pennsylvania stands first in this respect in 1909 with West Virginia second, Maryland third, Colorado fourth, and Montana fifth. Wyoming led in the production of lignite, or subbituminous coal, in 1909, with Colorado second, Texas third, New Mexico fourth, and North Dakota fifth. In the cases of North Dakota and Texas the production included in this class is entirely lignite, or brown coal; in the other States it is for the greater part subbituminous coal, or black lignite. The classification of what was formerly called black lignite in the Rocky Mountain States was an error, as that product is entirely distinct from the true lignite or brown coal. It is not lignitic in chemical composition nor physical characteristics, but lies between the lignite, or brown coal, and the true bituminous coal, and in order that a proper distinction may be made the term "subbituminous" has been adopted by the United States Geological Survey as properly applicable. West Virginia and Kentucky are credited with the entire production of splint coal, the former State being by far the more important. Indiana has practically the monopoly in the production of block coal, although small tonnages are reported from Illinois, Ohio, Kentucky, Iowa, Tennessee, and Alabama. A comparatively small amount of cannel coal is produced in Pennsylvania, West Virginia, Ohio, Indiana, Kentucky, Iowa, and Missouri.

Classification of the coal product of the United States in 1908, by States and Territories, in short tons.

State or Territory.	Bituminous.	Anthracite.	Semibituminous.	Lignite and subbituminous.	Semianthracite.	Block.	Splint.	Cannel.	Total.
Pennsylvania	113,915,977	83,268,754	3,238,946		297			24,307	200,448,281
Illinois	47,609,595		39,000			11,095			47,659,690
West Virginia	33,299,669		4,352,619				4,181,186	64,369	41,897,843
Ohio	26,261,132					8,642		865	26,270,639
Indiana	11,423,824		48,257			a 812,579		30,230	12,314,890
Alabama	b 11,604,593								11,604,593
Kentucky	9,716,584		166,243			5,000	269,592	c 89,134	10,246,553
Colorado	7,323,762	13,820	416,085	1,881,306					9,634,973
Iowa	7,076,096					62,496		22,718	7,161,310
Kansas	6,245,508								6,245,508
Tennessee	6,195,971					3,200			6,199,171
Wyoming	4,282,828		266,310	940,764					5,489,902
Maryland	1,105,789		3,271,304						4,377,093
Virginia	4,163,915		59,360		35,767				4,259,042
Missouri	3,307,583		5,549					4,183	3,317,315
Washington	2,604,195		193,792	226,956					3,024,943
Oklahoma	2,701,183		182,198		63,535	1,200			2,948,116
New Mexico	1,898,299	27,838	2,750	539,050					2,467,937
Arkansas	1,375,739		24,122		678,496				2,078,357
Montana	1,197,906		608,423	113,861					1,920,190
Texas	1,047,407			847,970					1,895,377
Utah	1,736,468		940	109,384					1,846,792
Michigan	1,835,019								1,835,019
North Dakota				320,742					320,742
Georgia	264,822								264,822
Oregon				86,259					86,259
California	9,000			9,755					18,755
Idaho	2,429			3,000					5,429
Alaska	196			2,911					3,107
Massachusetts				50					50
Total	308,205,489	83,310,412	12,875,898	5,082,008	778,095	904,212	4,450,778	235,806	415,842,698

a Includes 23,577 tons of semiblock coal.

b Includes 5,260 tons of semicannel coal.

c Includes 6,201 tons of semicannel coal.

Classification of the coal product of the United States in 1909, by States and Territories, in short tons.

State or Territory.	Bituminous.	Anthracite.	Semibituminous.	Lignite and subbituminous.	Semianthracite.	Block.	Splint.	Cannel.	Total.
Pennsylvania	129,217,021	81,059,159	8,698,423					51,347	219,025,950
West Virginia	39,462,559		7,642,822				4,502,995	[a] 240,844	51,849,220
Illinois	50,861,476					43,514			50,904,990
Ohio	27,396,770		478,847			30,246		33,778	27,939,641
Indiana	14,078,302		16,327			[b] 716,954		22,676	14,834,259
Alabama	13,449,960		45,862			207,628			13,703,450
Colorado	6,770,001	55,701	1,707,928	2,182.248	1,058				10,716,936
Kentucky	9,884.860		134,093			28,200	582,362	67,869	10,697,384
Iowa	7,707,590					28,500		21,672	7,757,762
Kansas	6,986,478								6,986,478
Wyoming	1,895,742		1,261.480	3,235,887					6,393,109
Tennessee	6,205,431		17,704		2,766	132,744			6,358,645
Virginia	4,711,710				40,507				4,752,217
Maryland	824,601		3,198,640						4,023,241
Missouri	3,750,594							5,936	3,756,530
Washington	3,137,283		51,065	413,915					3,602,263
Oklahoma	2,975,445		68,824	943	74,165				3,119,377
New Mexico	2,170,216	21,999	800	608,113					2,801,128
Montana	876,165		1,445,049	232,726					2,553,940
Arkansas	886,899		185,780		1,304,478				2,377,157
Utah	1,909,281		48,724	78,114	230,780				2,266,899
Texas	1,112,228			712,212					1,824,440
Michigan	1,784,692								1,784,692
North Dakota				422,047					422,047
Georgia	211,196								211.196
Oregon	5,972			81,304					87,276
California	35,984			9,852					45,836
Idaho	1,553			3,000					4,553
Alaska	100			2,700					2,800
Total	338,310,109	81,136,859	25,002 368	7,983,061	1,653,754	1,187,786	5,085,357	444,122	460,803,416

[a] Includes 121,000 tons of semicannel coal.

[b] Includes 16,800 tons of semiblock coal.

LABOR STATISTICS.

The statistics regarding the labor employed in the coal mines of the United States in 1909 were collected on the general schedules of the Bureau of the Census, and the inquiries were of such a character that the compilations are not comparable with the statistics presented in the previous reports of this series. A preliminary compilation made by the Bureau of the Census shows that there was a total of 666,555 men employed in the anthracite and bituminous mines of the United States in 1909. The statistics covering the number of days worked or the number of hours to the working days have not been compiled. In 1908 there were 690,438 men employed. Of the 666,555 men employed in 1909, according to the Bureau of the Census, 166,801 were in the anthracite mines of Pennsylvania, and 499,754 were in the bituminous mines.

The smaller number of men employed in 1909 as compared with 1908, notwithstanding the increased production in the later year, is accounted for by the exodus to their native lands in the latter part of 1908 of foreign miners, many of whom had not returned to their working places up to the close of 1909, nor had their places been filled by others.

The average production per man in 1909 was 691 tons. The average production in the anthracite region was 486 tons, and in the bituminous fields 759 tons. In 1908 the average production per man in the anthracite region was 478 tons, and in the bituminous regions 644 tons, and the general average was 602 tons.

LABOR TROUBLES.

So far as the time lost through strikes or suspensions is concerned, the year 1909 was in marked contrast to 1908. With the exception of 1901 there were fewer men on strike in 1909 than in any one of the last 10 years. In 1901, however, the strikes that occurred were of longer duration than those in 1909 and the aggregate time lost was greater. In 1907 there were more men on strike than in 1909, but fewer days were lost. During the last 10 years in which these statistics of labor troubles have been compiled by the Geological Survey the "even" years show a larger number of men on strike in the bituminous region and also a larger aggregate in the time lost than in the "odd" years. The reason for this is that the wage agreements in the organized States terminate on March 31, of the even years, and before the renewals are agreed upon suspensions of longer or shorter duration have occurred with regrettable regularity. In 1900, 131,973 men were on strike and the total time lost was 4,878,102 working days. In 1902, 200,452 men were on strike, and the total time lost was 16,672,217 working days. In 1904, 77,661 men were on strike, and the total time lost was 3,382,830 working days. The record in this respect was held by 1906, when 372,343 men were on strike and the total time lost was 19,201,348 working days. In 1908 there were 145,145 men idle for an average of 38 working days each, involving an aggregate in time lost of 5,449,938 working days. In 1909 the total number of men on strike in the bituminous fields was 24,763 who were idle an average of 29 days each, and the aggregate time lost was 723,634 working days. The regular periodicity of the suspensions in the bituminous region has resulted in an indirect loss to the industry in addition to those involved in the immediate difficulties, for large consumers weary of the interruptions to their supplies of fuel have in some cases turned to oil and natural gas as a source of power. This has been particularly true in some of the middle Western States, where the interruptions to coal mining have been more pronounced.

In the anthracite region the interruptions to operations in 1909 were negligible in number and in their influence upon the production. There were only three cases of strikes or suspensions reported, and one of these where the largest number of men was involved was for only one day. Altogether there were 771 men on strike in the anthracite region and the average time lost was a fraction over 10 days for each. Since the settlement of the famous strike of 1902, effected by the Anthracite Coal Strike Commission, industrial peace and prosperity have reigned in the anthracite region. The awards of the commission were to cover a period of three years, ending March 31, 1906. At their termination on that date they were renewed by the operators and miners for another period of three years, ending March 31, 1909. There was some apprehension of suspension at the termination of this renewal, and in anticipation of a shutdown mining operations were conducted with unwonted activity for several months preceding that date. It is gratifying, however, to be able to record that the apprehensions of a shutdown were not realized and that with a few unimportant modifications the awards were renewed for a second time for another period of three years, terminating on March 31, 1912. Local disaffections will, of course, occasionally occur, and these were the only kind that took place during 1909. There were no instances of riot or serious disorder reported in 1909.

The statistics of labor troubles in the coal mines of the United States in 1908 and 1909 are presented in the following table:

Statistics of labor strikes in the coal mines of the United States in 1908 and 1909.

State or Territory.	1908			1909		
	Number of men on strike.	Total days lost.	Average number of days lost per man.	Number of men on strike.	Total days lost.	Average number of days lost per man.
Alabama	8,397	373,513	44			
Arkansas	4,037	387,841	96	1,443	41,836	29
Colorado	768	16,646	22	55	1,250	23
Illinois	47,456	1,737,611	37	2,335	90,720	38
Indiana	7,076	157,899	22	36	720	20
Iowa	5,248	121,087	23	2,036	12,504	6
Kansas	11,155	665,224	60	4,715	71,566	15
Kentucky	1,002	26,941	27	275	16,500	60
Maryland				25	175	7
Michigan	300	4,800	16	527	23,002	44
Missouri	6,350	355,138	56	957	6,593	7
Montana	556	9,201	17	110	1,100	10
North Dakota	104	1,620	16	75	525	7
Ohio	21,084	567,450	27	2,375	139,434	59
Oklahoma	6,929	398,251	57	1,576	11,368	7
Oregon						
Pennsylvania	18,780	375,569	20	5,824	260,381	45
Tennessee	349	11,441	33	277	9,295	34
Texas	169	338	2	80	4,800	60
Utah						
Washington	226	67,800	300	123	2,300	19
West Virginia	501	71,992	144	1,919	29,565	15
Wyoming	4,658	99,576	21			
Total bituminous	145,145	5,449,938	38	24,763	723,634	29
Pennsylvania anthracite				771	8,016	10

A summary of the statistics of strikes in the coal mines of the United States since 1889 is given in the following table:

Summary of labor strikes in the coal mines of the United States, 1899–1909.

Year.	Number of men on strike.	Total working days lost.	Average number of days lost per man.
1899	45,981	2,124,154	46
1900	131,973	4,878,102	37
1901 [a]	20,593	733,802	35
1902	200,452	16,672,217	83
1903 [a]	47,481	1,341,031	28
1904	77,661	3,382,830	44
1905	37,542	796,735	21
1906	372,343	19,201,348	51.5
1907 [a]	32,540	462,392	14
1908 [a]	145,145	5,449,938	38
1909 [a]	24,763	723,634	29

[a] Bituminous mines only.

COAL MINED BY MACHINES.

Coal mining at its best is an exacting and unattractive kind of employment, and anything which tends to the amelioration of the conditions in the coal mines indicates progress. As the sewing machine has to a great extent supplanted the needle, and the machine reaper has taken the place of the hand-swung cradle on the farm, so has the coal-mining machine reduced in a marked degree the arduous character of the miner's employment. The increasing use of machines for mining reduces by so much the reprehensible practice of shooting from the solid, to which is justly ascribed the responsibility for a portion, at least, of the large number of accidents in the coal mines of the United States. In late years there has been a growing disinclination on the part of the miner to undercut the coal when it has to be done by hand, resulting in a larger quantity of coal being shot from the solid, with the increased danger to life, limb, and property, which is the consequence of efforts to make powder do the work of the miner. The progress made in the mining of coal by machinery is gratifying, and it would have probably been much more so except for the differentials against machine-mined coal in the wage-scale agreements. During the last two years the progress in the manufacture of mining machinery has been principally in the bringing out of cutters adapted to use in the steeply inclined beds. These cutters are a combination of the principle of the punching machine and the air rock drill. This new type of cutter is practically the punching machine mounted on a post and radially actuated. It can be set in a mine having any inclination from the horizontal, and can be used for undercutting or holing, for cutting out a clay band in any part of the bed, or for shearing. The limit of inclination in the older type of machine was about 12 degrees for a chain machine, and not more than 15 degrees for a puncher. When undercutting machinery is mentioned in these reports reference is made only to the bituminous coal mines. No undercutting nor shearing machines are used in the anthracite mines. The total quantity of bituminous coal (including lignite) mined by the use of machines, in 1909, was 142,496,878 short tons, an increase of 19,313,544 short tons, or 15.7 per cent, over the machine-mined product, 123,183,334 short tons, in 1908. The percentage of the machine-mined product to the total production in the States where mining machines were used has increased from 35.71 in 1907 to 37.52 in 1908 and to 38 in 1909. The machine-mined production in 1909 was 37.5 per cent of the total output of bituminous coal in the United States.

The progress made in the use of mining machinery within the last ten years is illustrated by the fact that in 1899 the total output won by machines was 43,963,933 short tons, or 22.7 per cent of the total bituminous production. In 1899 3,125 machines were in use. In 1909 there were 13,049 machines in use. In 1908 there were 11,569 machines used, and in 1907, 11,144. In the record-making production of coal in 1907 the average production for each machine was 12,381 short tons; this average dropped in the reduced production of 1908 to 10,648 tons, and increased again to 10,920 tons in 1909. Of the 13,065 machines used in 1909, 7,121 were punchers, including those of the post or radial type already referred to; 5,592 were chain machines; and 352 were long-wall. The number of long-wall machines includes a few "short-wall" machines, and some continuous cutters, which are built somewhat on the lines of the long-wall machines. Some machines, both of the puncher and of the chain type, are used for shearing work. A few of the original cutter-bar machines are also in use, but that type is no longer made.

According to reports received from the manufacturers of mining machines, showing the total number of machines which they have manufactured, nearly one-half of those that have been constructed have been worn out, scrapped, or discarded. According to these statements, 9,897 chain machines altogether, including long-wall and short-wall machines, have been manufactured; in 1909 only 5,592 chain machines and 352 long-wall machines, a total of 5,944 machines of these types, were in use. The total number of machines manufactured includes 228 cutter-bar machines, of which only a very few are now in use. The number of punching machines manufactured, including 407 of the new type of punchers operated on a post, is 13,539; and in 1909 there were 7,121 punchers in use.

There were 420 mines in the United States in 1909 where pick machines exclusively were in use, and in 585 mines chain-breast machines exclusively were employed. The total number of pick machines in such mines was 5,591, and by their use 39,355,829 tons of coal were mined. In the exclusively chain-machine mines 4,253 machines produced 69,926,367 short tons of coal. The average quantity of coal mined in 1909 by each punching machine was 7,039 tons, and by each chain machine, 16,442 tons. In considering this difference apparently so much in favor of the chain-breast type of machine, the higher cost of installation of the chain machine must be borne in mind and it must also be remembered that large numbers of the punching machines are used in driving entries and in other narrow work to which chain machines are not adapted and in which the tonnage won is much less than that obtained in regular mining work.

Pennsylvania, the leading State in the total production of bituminous coal, leads also in the number of machines employed and in the quantity of coal mined by them, but in the percentage of machine-mined coal to the total product, Ohio takes first place. Pennsylvania bituminous mines employed 5,616 machines in 1909, which produced 57,504,188 short tons, or 41.68 per cent of the State's total production of bituminous coal; Ohio mines employed 1,433 machines, which produced 22,148,216 tons, or 79.5 per cent of the State's total. Of the 5,616 machines in Pennsylvania, 3,847 were punchers; of the 1,433 machines in Ohio, 1,314, or 93 per cent, were chain machines. Ohio was second in the quantity of machine-mined tonnage, West Virginia third, and Illinois fourth. Kentucky is second in the percentage of machine-mined coal, Indiana third, Pennsylvania fourth, and West Virginia fifth.

The statistics in regard to the coal mined by machines during the last five years are shown in the following table, together with the number of machines used in each State, the number of tons mined by machines, the total production of the States in which machines were used, and the percentage of the machine-mined product to the total of those States.

Bituminous coal mined by machines in the United States, 1905–1909, by States and Territories.

State or Territory.	Number of machines in use.					Number of tons mined by machines.				
	1905.	1906.	1907.	1908.	1909.	1905.	1906.	1907.	1908.	1909.
Alabama	213	238	197	197	283	1,584,942	1,641,476	1,762,948	1,783,516	2,203,619
Colorado	121	141	175	211	253	1,247,687	1,337,006	1,689,517	1,668,602	1,929,545
Georgia	6					11,684				
Illinois	882	1,048	1,080	1,217	1,260	8,697,547	11,585,419	15,134,401	15,045,004	17,488,427
Indiana	506	471	513	507	631	4,207,246	4,251,740	5,310,607	5,294,092	7,408,829
Iowa	32	34	33	28	5	186,224	193,666	108,022	71,463	7,500
Kansas	10	6	6	17	16	19,101	30,450	35,317	133,248	59,976
Kentucky	527	600	708	759	877	4,409,054	5,175,950	5,504,262	5,252,753	6,461,593
Maryland	42	45	43	39	39	468,822	427,450	479,110	208,134	117,568
Michigan	106	110	103	120	101	432,266	417,073	606,718	535,543	511,895
Missouri	30	48	62	57	96	375,194	419,288	486,882	479,850	796,438
Montana	58	76	86	57	81	752,665	974,306	984,368	713,217	840,686
New Mexico			3	7	4			11,615	30,600	1,352
North Dakota	9	11	12	11	16	97,789	97,035	136,700	104,884	112,365
Ohio	1,041	1,255	1,328	1,343	1,433	16,888,417	20,004,416	24,843,616	19,799,140	22,148,216
Oklahoma (Indian Territory)	29	29	11	17	34	40,203	33,357	24,331	31,352	50,812
Pennsylvania	4,254	4,515	4,940	5,103	5,616	49,335,660	54,146,314	60,771,157	52,447,809	57,504,188
Tennessee	89	128	137	122	197	479,471	747,500	874,925	787,502	1,040,798
Texas	8	12	13	6	11	22,400	22,682	36,100	15,000	17,230
Utah		2	5				1,000	1,800		
Virginia	35	37	77	85	107	399,029	424,343	788,793	1,035,832	1,323,111
Washington		1		4	18		12,521		20,000	48,690
West Virginia	1,105	1,322	1,533	1,574	1,844	12,504,301	15,565,113	17,627,925	16,653,174	20,993,489
Wyoming	81	83	79	88	127	1,236,750	1,339,422	1,328,709	1,072,619	1,430,551
Total	9,184	10,212	11,144	11,569	13,049	103,396,452	118,847,527	138,547,823	123,183,334	142,496,878

Bituminous coal mined by machines in the United States, 1905–1909, by States and Territories—Continued.

State or Territory.	Total tonnage of States using mining machinery.					Percentage of total product mined by machines.				
	1905.	1906.	1907.	1908.	1909.	1905.	1906.	1907.	1908.	1909.
Alabama	11,866,069	13,107,963	14,250,454	11,604,593	13,703,450	13.36	12.52	12.37	15.37	15.02
Colorado	8,826,429	10,111,218	10,790,236	9,634,973	10,716,936	14.14	13.22	15.66	17.32	18.00
Georgia	351,991	......	......	......	......	3.32	......	......	......	......
Illinois	38,434,363	41,480,104	51,317,146	47,659,690	50,904,990	22.63	27.93	29.49	31.57	34.00
Indiana	11,895,252	12,092,560	13,985,713	12,314,890	14,834,259	35.37	35.16	37.97	42.99	50.00
Iowa	6,798,609	7,266,224	7,574,322	7,161,310	7,757,762	2.74	2.67	1.43	1.00	.10
Kansas	6,423,979	6,024,775	7,322,449	6,245,508	6,986,478	.30	.51	.48	2.13	.85
Kentucky	8,432,523	9,653,647	10,753,124	10,246,553	10,697,384	51.44	53.62	51.19	51.27	60.50
Maryland	5,108,539	5,435,453	5,532,628	4,377,093	4,023,241	9.18	7.86	8.66	4.76	2.90
Michigan	1,473,211	1,346,338	2,035,858	1,835,019	1,784,692	29.34	30.98	29.80	29.18	28.70
Missouri	3,983,378	3,758,008	3,997,936	3,317,315	3,756,530	9.42	11.16	12.18	14.47	21.20
Montana	1,643,832	1,829,921	2,016,857	1,920,190	2,553,940	45.79	53.24	48.81	37.14	32.90
New Mexico	......	......	2,628,959	2,467,937	2,801,128	......	......	.44	1.24	......
North Dakota	317,542	305,689	347,760	320,742	422,047	30.80	31.74	39.31	32.70	27.26
Ohio	25,552,950	27,731,640	32,142,419	26,270,639	27,939,641	66.10	72.14	77.29	75.37	79.50
Oklahoma (Indian Territory)	2,924,427	2,860,200	3,642,658	2,948,116	3,119,377	1.37	1.17	.67	1.06	1.50
Pennsylvania	118,413,637	129,293,206	150,143,177	117,179,527	137,906,791	41.66	41.88	40.48	44.76	41.68
Tennessee	5,766,690	6,259,275	6,810,243	6,199,171	6,358,645	8.31	11.94	12.85	12.70	16.40
Texas	1,200,684	1,312,873	1,648,069	1,895,377	1,824,440	1.86	1.73	2.19	.79	.94
Utah	......	1,772,551	1,947,607	......	......	......	.06	.09	......	......
Virginia	4,275,271	4,254,879	4,710,895	4,259,042	4,752,217	9.33	9.97	16.74	24.32	27.88
Washington	......	3,276,184	......	3,024,943	3,602,263	......	.38	......	.66	1.35
West Virginia	37,791,580	43,290,350	48,091,583	41,897,843	51,849,220	33.09	35.96	36.65	39.75	40.80
Wyoming	5,602,021	6,133,994	6,252,990	5,489,902	6,393,109	22.08	21.84	21.25	19.54	22.38
Total	307,082,977	338,597,052	387,943,083	328,270,373	374,688,540	a 33.67	a 35.10	a 35.71	a 37.52	a 38.03

a Average.

It is interesting to observe to what extent the different types of machines are apparently preferred in the more important coal-producing States. In Ohio, where nearly 80 per cent of the total coal mined is undercut by machines, the chain machine is almost universally used, 1,314 out of a total of 1,433 machines in use in1909 being of the chain-breast pattern. In West Virginia, where 41 per cent of the total production was mined by machines, 1,036 chain machines and 700 punchers were used. In Indiana, half of whose product in 1909 was mined by machines, 227 punchers were used and 391 chain-breast machines. Punching machines are preferred in Illinois, as shown by the fact that 845 of that type were used in 1909, as compared with 405 chain machines. Punchers are also more in favor in Pennsylvania and in Kentucky, the latter State being the second in the percentage of machine-mined coal to the total. In Pennsylvania, out of 5,616 machines in use 3,847 were punchers, and in Kentucky, out of 877 machines 547 were of that type. Missouri is the only State in which longwall machines have precedence. This is due to the fact that many of the coal beds are thin and favorable to the longwall method of mining.

One of the determining factors in the choice of machines for undercutting coal is the character of the roof, it being impracticable to operate chain machines in mines where the timbering has to be kept up close to the face. The figures indicate that in Ohio, West Virginia, and Indiana there is a large percentage of mines with strong roofs overlying the coal.

In the following table are shown the number and kind of machines in use in each State in 1908 and 1909:

Number and kinds of machines in use in 1908 and 1909, by States and Territories.

State or Territory.	1908.				1909.			
	Pick.	Chain breast.	Long-wall.	Total.	Pick.	Chain breast.	Long-wall.	Total.
Alabama	142	51	4	197	192	74	17	283
Colorado	137	56	18	211	175	66	12	253
Illinois	876	338	3	1,217	845	405	10	1,260
Indiana	140	332	35	507	227	391	13	631
Iowa	19	9	....	28	5	....	....	5
Kansas	10	7	....	17	14	2	....	16
Kentucky	515	209	35	759	547	310	20	877
Maryland	39	....	....	39	39	....	....	39
Michigan	85	33	2	120	66	34	1	101
Missouri	5	....	52	57	4	18	74	96
Montana	53	4	....	57	72	9	....	81
New Mexico	7	....	....	7	....	4	....	4
North Dakota	....	9	2	11	7	9	....	16
Ohio	135	1,203	5	1,343	97	1,314	22	1,433
Oklahoma	15	2	....	17	28	4	2	34
Pennsylvania	3,436	1,659	8	5,103	3,847	1,731	38	5,616
Tennessee	96	18	8	122	119	54	24	197
Texas	6	....	....	6	2	6	3	11
Virginia	14	71	....	85	21	82	4	107
Washington	4	....	....	4	15	3	....	18
West Virginia	599	899	76	1,574	700	1,036	108	1,844
Wyoming	47	40	1	88	85	38	4	127
Total	6,380	4,940	249	[a]11,569	7,107	5,590	352	13,049

[a] Includes 26 pick and 238 chain shearing machines.

The statistics relating to the use of mining machines were first collected by the Geological Survey for the year 1896. The inquiries at that time covered the number of machines in use and the quantity of coal won by them in 1891, five years before. From the returns to the Geological Survey since 1896, the results of which have been published in detail in the preceding volumes, Mineral Resources of the United States, the following table has been prepared, showing the development in the mechanical mining of bituminous coal since 1891:

Production of coal by machines in the United States since 1891, in short tons.

Year.	Number of machines in use.	Total tonnage won by machines.	Average production for each machine.
1891	545	6,211,732	11,398
1896	1,446	16,424,932	11,373
1897	1,956	22,649,220	11,579
1898	2,622	32,413,144	12,362
1899	3,125	43,963,933	14,068
1900	3,907	52,784,523	13,510
1901	4,341	57,843,335	13,325
1902	5,418	69,611,582	12,848
1903	6,658	77,974,894	11,712
1904	7,663	78,606,997	10,258
1905	9,184	103,396,452	11,258
1906	10,212	118,847,527	11,638
1907	11,144	137,973,701	12,381
1908	11,569	123,183,334	10,648
1909	13,049	142,496,878	10,920

In the following table a statement is presented covering the number of pick machines and chain machines in mines where each type is used exclusively, and the production by such machines:

Production of coal by punching and chain-breast machines, where each type is used exclusively, in 1909, by States.

State.	Punchers.		Chain-breast machines.	
	Number.	Production (short tons).	Number.	Production (short tons).
Alabama	171	887,793	18	125,626
Colorado	134	1,135,733	38	296,129
Illinois	644	5,940,569	379	8,274,350
Indiana	206	1,743,490	302	4,476,919
Kansas	14	51,618	2	8,358
Kentucky	400	1,895,288	263	3,003,323
Maryland	39	117,568	....	....
Michigan	66	245,976	22	154,567
Missouri	4	8,491	18	117,146
Montana	71	771,296	9	63,600
New Mexico	0	0	4	1,352
North Dakota	7	16,000	9	96,365
Ohio	71	364,420	1,232	19,339,022
Oklahoma	28	30,504	3	11,902
Pennsylvania	3,132	22,741,280	1,265	24,016,842
Tennessee	97	480,092	32	132,535
Texas	2	4,608	6	6,000
Virginia	16	36,902	66	1,105,552
Washington	12	40,000	....	....
West Virginia	414	2,207,277	572	8,542,906
Wyoming	63	636,924	13	153,873
Total	5,591	39,355,829	4,253	69,926,367

COAL-MINING ACCIDENTS.

During the last five years the annual reports of the United States Geological Survey on the production of coal have contained a chapter on coal-mining accidents, their causes, and their relations to the number of men employed, and the tonnage produced. These statistics are compiled almost entirely from statements received through the courtesy of State mine inspectors.

Coal-mine fatalities in the United States in 1909 were fewer than in 1908, notwithstanding an increase of 10.8 per cent in the quantity of coal mined. The total number of deaths from coal-mine accidents in 1909 was 2,412, against 2,450 in 1908.

The decrease in the number of fatal accidents during 1909 is all the more gratifying from the fact that the statistics for that year include four States, namely, Georgia, Oregon, Texas, and Virginia, from which no reports of accidents had previously been received. The statistics for these States were compiled from reports received by the Geological Survey from the operators. The reports of men killed in 1909 in the four States from which no reports were received in 1908 was 34, which makes the showing for 1909 still more favorable. The total production of coal in 1909 amounted to 460,803,416 short tons, against 415,842,698 in 1908, according to which the quantity of coal mined for each life lost was 191,046 short tons in 1909, against 167,545 tons in 1908. In 1907, when 3,125 men were killed, there were 145,471 tons mined for each life lost. This was the year in which the darkest record was made in the history of the industry. During December, 1907, there was an epidemic of coal-mine explosions, the echoes from one hardly having died away before another horror occurred. Fortunately, although disasters of this kind have occurred all too frequently during the last two years, the black record of 1907 has not been repeated, and commendable efforts are being made throughout the coal-mining regions to lessen the hazardous character of the mine-workers' employment.

According to a preliminary compilation made for this report by the Bureau of the Census, there were 666,555 men employed in the coal mines of the United States, from which it appears that the death rate per thousand employees was 3.62. In 1908 it was 3.6 and in 1907 it was 4.86.

In the number of nonfatal accidents the record for 1909 does not exhibit as favorable comparison with previous years as do the statistics of fatalities. The number of men injured in 1909 reached the unprecedented total of 7,979, an increase of more than 1,200 over 1908, and 1908 showed an increase in nonfatal accidents of more than 1,400 over 1907. A part of this increase is undoubtedly due to the more complete information received during the last two years. In 1907 statistics were obtained from only 17 States; in 1908 the statistics included 21 States; and in 1909 reports were received from 26 States. Over 500 of the nonfatal injuries were reported in 1909 from the four States, the statistics of which were collected by the Geological Survey. But it is believed that by far the most important factor in the increase in the number of nonfatal accidents is the growing tendency in most of the bituminous districts of "shooting the coal from the solid."

It is to be noted that in the anthracite mines of Pennsylvania the number of nonfatal accidents decreased from 1,369 in 1907 to 1,170 in 1908 and to 1,034 in 1909, while those in the bituminous mines increased from 3,947 in 1907 to 5,602 in 1098 and to 6,945 in 1909. These figures are significant and, taken in connection with the fewer number of fatal accidents, require some other explanation than the more complete returns of the last two years, particularly as the less complete reports previous to 1909 included returns from all of the large producing States.

Because of the fact that when an explosion or such a holocaust as that of the Cherry (Ill.) mine occurs, the news of the horror is spread broadcast over the country in the press dispatches, the prevalent opinion is that the danger from explosion and from fire and suffocation are the greatest to which the workers in the black pits of the coal mines are exposed. Such, however, is not the case. It is true that so long as coal is mined fires and explosions will occur. The danger is ever present and is greater in some mines than in others, but when one considers the industry as a whole, the number of victims of fire and explosion becomes comparatively few. The greatest danger to which the miner is exposed is that from falls of roof and coal, and this danger is materially increased from the weakening of the roof and the shattering of the coal left as supporting pillars when excessive charges of powder are used. In 1909, of the 2,412 men killed 1,191, or 49 per cent, were victims of falls of roof or coal, and of the 7,979 nonfatal injuries, 3,280, or 41 per cent, were due to this cause. Only 14 per cent of the deaths and less than 5 per cent of the injuries were due to explosions of dust or gas or of combinations of the two. As indicating the relatively more fatal character of explosion, as compared with the other causes of coal-mine accidents, it is to be noted that 341 men were killed and 331 injured in the explosions that occurred in 1909; in the accidents due to windy or blown-out shots and to explosions of powder or dynamite, 108 men were killed and 217 injured; falls of coal and roof killed 1,191 and injured 3,280; and in the accidents due to miscellaneous causes, 759 were killed and 3,875 injured. In 1908 the corresponding figures were—from gas and dust explosions, 396 killed and 326 injured; from powder explosions and windy shots, 73 killed and 179 injured; from falls of roof and coal, 1,080 killed and 2,591 injured; and from miscellaneous causes, 901 killed and 3,676 injured. The same comparison may be made when the statistics for a series of years are considered. The present report includes a statement of the accidents in coal mines, distributed by causes, for all the years the statistics are available. In some States the causes have been reported only for the last three years; in others the statistics cover a period of twenty-five years, sometimes intermittently and sometimes consecutively. During this period the total number of deaths for which the causes have been assigned was 31,056, and the nonfatal accidents were 74,554. Of these gas and dust explosions killed 4,150 and injured 4,612 (two-thirds of those injured being in the anthracite mines of Pennsylvania); powder explosions and windy shots killed 2,047 and injured 4,498; falls of roof and coal killed 14,939 and injured 32,609; and 9,920 deaths and 32,835 injuries were due to other causes. It is to be observed that nearly 50 per cent of the total number of deaths were from falls of roof and that only 13 per cent were due to explosions of gas and dust. Another interesting feature is that the explosions in the anthracite mines show a much smaller rate of mortality than those in the bituminous mines. This is probably due to the comparatively inert character of the anthracite dust, which does not propagate a series of explosions, as the dust in bituminous mines is likely to do when ignited by an explosion of fire damp or otherwise. Explosions in the anthracite mines are in consequence more localized and are attended with comparatively fewer fatal results.

The most serious catastrophe which occurred during the calendar year 1909 was the fire at the Cherry mine of the St. Paul Coal Company, at Cherry, Bureau County, Ill. It has been reported that in that disaster 393 men were burned or suffocated. The statistics of the holocaust are not, however, included in the preceding general statements, for the reason that the reports of the state mine inspectors of Illinois are made for the fiscal year ended June 30, and as the Cherry disaster occurred in November it will be included in the statistics for the fiscal year ended June 30, 1910.

The most serious single accident included in the statistics presented in this statement was an explosion at the Lick Branch colliery of the Pocahontas Consolidated Collieries Company, near Bluefield, W. Va., on January 12, 1909. In that explosion 65 men were killed and 1 was injured. Another explosion had occurred in this mine about two weeks before in which 51 lives were lost. The Lick Branch explosions were the only ones of serious proportions which occurred in West Virginia during the year.

An explosion in Mine A of the Chicago and Cartersville Coal Company, at Herrin, Ill., on December 28, 1909, killed 8 men and imperiled the lives of 400 others.

Twelve men were killed by what is supposed to have been an explosion of dynamite in one of the mines of the Cambria Steel Company, near Johnstown, Pa., October 31, 1909.

On April 9, 1909, an explosion of dynamite killed 7 miners and injured several others at mine No. 37 of the Berwind-White Coal Company, near Windber, Pa.

On January 25 there were 4 men killed and 8 injured in Washington mine No. 5 of the Piedmont and Georges Creek Coal Company, in Maryland, as the result of a collision between coal cars.

Five men were killed and 20 injured in an explosion at the Sunnyside mine of the Sunnyside Coal and Coke Company in Vanderburg County, Ind., on March 19. Twenty-nine men were in the mine at the time of the explosion, and all but 5 escaped.

An explosion which caused the death of 20 men occurred January 10 in the mine of the Zeigler Coal Company at Zeigler, Franklin County, Ill.

What is supposed to have been a dust explosion occurred in April at the Short Creek mine of the Birmingham Coal and Iron Company, in Jefferson County, Ala., and killed 18 men.

For the figures from which the statistics of coal-mine accidents have been prepared acknowledgments are due to the following officials: Mr. Edward Flynn, chief mine inspector, Alabama; Mr. James Douglas, state mine inspector, Arkansas; Mr. John D. Jones, state coal-mine inspector, Colorado; Mr. David Ross, secretary of the bureau of labor statistics, Illinois; Mr. James Epperson, state mine inspector, Indiana; Mr. John Verner, formerly inspector of the first mining district; Mr. R. T. Rhys and Mr. Edward Sweeney, inspectors of the second and third mining districts of Iowa; Mr. Frank Gilday, state mine inspector, Kansas; Mr. C. J. Norwood, state geologist and chief inspector of mines, Kentucky; Mr. John H. Donahue, mine inspector, Maryland; Mr. M. J. McLeod, commissioner of labor, Michigan; Mr. George Bartholomaeus, secretary of the state bureau of mines, Missouri; Mr. J. B. McDermott, state mine inspector, Montana; Mr. Jo E. Sheridan, territorial mine inspector, New Mexico; Mr. T. R. Atkinson, state mine inspector, North Dakota; Mr. George Harrison, state mine inspector, Ohio; Mr. Peter Hanraty, state mine inspector, Oklahoma; Mr. James E. Roderick, chief of the department of mines, Pennsylvania; Mr. J. W. Allen, statistician for the state bureau of mines, Tennessee; Mr. S. J. Taylor, state mine inspector, Texas; Mr. J. E. Pettit, state mine inspector, Utah; Mr. D. C. Botting, state mine inspector, Washington; and Mr. John Laing, chief of the department of mines, West Virginia.

In the following tables the fatal and nonfatal accidents in coal mines are segregated according to the principal causes in 1908 and 1909, by States, with a résumé of the fatal accidents, as reported in each State. A tabular statement of the total number of fatal and nonfatal accidents in each State is also presented for as many of the last twenty-five years as statistics are available. In several of the important States the records are complete for the full twenty-five years.

Causes of fatal and nonfatal accidents in coal mines in 1908 and 1909, by States and Territories.

State or Territory.	Gas and dust explosions.		Powder explosions and windy shots.		Falls of roof or coal.		Other causes.		Total.	
	Killed.	Injured.	Killed.	Injured.	Killed.	Injured.	Killed.	Injured.	Killed.	Injured.
1908.										
Alabama	9	12	2	1	39	14	58	31	108	58
Arkansas	1	8	1	1	8	10	4	24	14	43
Colorado	5	8	2	1	39	57	15	49	61	115
Illinois [a]	9	33	25	39	93	404	56	343	183	819
Indiana	5	33	0	3	20	212	20	582	45	830
Iowa	1	0	2	6	19	49	9	35	31	90
Kansas [a]	7	20	0	0	14	15	6	35	27	70
Kentucky	9	1	3	4	17	42	10	80	39	127
Maryland [a]	0	0	0	2	4	55	8	39	12	96
Michigan	0	0	1	10	4	45	0	46	5	101
Missouri	0	0	0	0	9	24	1	12	10	36
Montana	0	6	1	5	7	25	13	22	21	58
New Mexico	0	(b)	1	(b)	15	(b)	7	(b)	23	(b)
North Dakota	0	0	0	2	2	1	2	1	4	4
Ohio	2	9	4	24	72	273	35	292	113	598
Oklahoma [a]	3	21	3	4	2	19	36	84	44	128
Pennsylvania:										
Anthracite	57	130	23	46	284	328	314	666	678	1,170
Bituminous	162	20	1	21	263	557	146	421	572	1,019
Tennessee	(b)	(b)	(b)	(b)	(b)	(b)	34	195	34	195
Utah	2	2	0	2	2	10	4	114	8	128
Washington	1	14	0	2	12	19	12	44	25	79
West Virginia	63	9	4	6	153	431	93	496	313	942
Wyoming	60	....	....	....	2	1	19	65	81	66
Total	396	326	73	179	1,080	2,591	902	3,676	2,451	6.772

[a] Fiscal year. [b] Not reported.

Causes of fatal and nonfatal accidents in coal mines in 1908 and 1909, by States and Territories—Continued.

State or Territory.	Gas and dust explosions.		Powder explosions and windy shots.		Falls of roof or coal.		Other causes.		Total.	
	Killed.	Injured.	Killed.	Injured.	Killed.	Injured.	Killed.	Injured.	Killed.	Injured.
1909.										
Alabama	24	15	10	4	70	20	25	20	129	59
Alaska	0	0	0	0	0	0	0	0	0	0
Arkansas (6 mos.)	6	5	3	0	0	14	3	15	12	34
California	0	0	0	0	0	0	0	0	0	0
Colorado	15	13	1	2	64	70	15	31	95	116
Georgia [a]	0	0	0	3	2	22	0	31	2	56
Illinois	40	25	29	38	84	423	60	408	213	894
Indiana	7	32	3	25	25	331	15	691	50	1,079
Iowa	1	0	1	1	22	49	13	53	37	103
Kansas [b]	6	24	4	3	21	50	4	14	35	91
Kentucky	7	1	0	3	20	43	7	51	34	98
Maryland [b]	0	0	0	0	13	47	4	29	17	76
Michigan	....	....	....	....	....	....	....	....	[c] 9	[c] 104
Missouri	0	0	3	2	14	17	4	4	21	23
Montana	0	2	1	2	8	20	2	20	11	44
New Mexico	0	0	0	0	9	31	4	146	13	177
North Dakota	0	0	0	0	0	2	0	0	0	2
Ohio	1	15	7	15	70	331	37	332	115	693
Oklahoma	24	24	2	0	4	33	10	50	40	107
Oregon	1	2	0	0	0	3	0	5	1	10
Pennsylvania:										
Anthracite	28	92	22	31	254	325	263	586	567	1,034
Bituminous	48	26	5	23	291	590	162	487	506	1,126
Tennessee	0	1	3	10	18	98	10	88	31	197
Texas	0	5	0	3	4	46	0	66	4	120
Utah	0	0	1	1	11	51	4	37	16	89
Virginia [d]	0	0	0	7	16	120	7	180	27	373
Washington	14	33	1	0	10	40	14	63	39	136
West Virginia [b]	119	16	10	44	144	504	91	468	364	1,032
Wyoming [b]	0	....	2	....	17	....	5	....	24	[c] 106
Total	341	331	108	217	1,191	3,280	759	3,875	2,412	7,979

[a] One company only.
[b] Fiscal year.
[c] Causes not given.
[d] Includes 4 men killed and 66 men injured, causes for which can not be given (1 company).

Causes of fatal and nonfatal accidents in coal mines of the United States to close of 1909, by States and Territories.

State or Territory.	Gas and dust explosions.		Powder explosions and windy shots. [a]		Falls of roof or coal.	
	Killed.	Injured.	Killed.	Injured.	Killed.	Injured.
Alabama	96	44	41	48	183	92
Arkansas	18	19	5	1	16	44
Colorado	275	165	35	90	640	1,338
Illinois	53	191	298	541	1,310	6,438
Indiana	28	136	49	151	212	1,477
Iowa	11	9	50	67	300	567
Kansas	24	55	23	58	130	299
Kentucky	21	23	32	89	220	660
Maryland	0	0	0	2	17	102
Michigan	1	0	3	10	8	71
Missouri	5	14	25	36	185	320
Montana	0	20	9	23	81	155
New Mexico	43	1	10	0	108	94
North Dakota	0	0	0	2	2	3
Ohio	23	115	97	351	981	3,487
Oklahoma	102	259	73	68	112	266
Pennsylvania:						
Anthracite	876	2,972	1,008	2,100	5,035	6,829
Bituminous	1,067	303	118	541	3,509	6,706
Tennessee	31	23	35	65	200	461
Texas	0	5	0	3	4	46
Utah	207	7	3	6	49	168
Virginia	0	0	0	7	16	120
Washington	169	144	12	24	124	384
West Virginia	930	107	119	215	1,472	2,475
Wyoming	60	0	2	0	25	7
Total	4,150	4,612	2,047	4,498	14,939	32,609

[a] Including premature and delayed blasts.

Causes of fatal and nonfatal accidents in coal mines of the United States to close of 1909, by States and Territories—Continued.

State or Territory.	Other causes.		Total specified by causes.		Total of all deaths and injuries.	
	Killed.	Injured.	Killed.	Injured.	Killed.	Injured.
Alabama	167	116	487	300	1,166	300
Arkansas	10	50	49	114	88	114
Colorado	218	837	1,168	2,430	1,168	2,630
Illinois	732	4,399	2,493	11,569	2,493	11,569
Indiana	164	2,311	453	4,075	651	4,235
Iowa	148	375	509	1,018	552	1,018
Kansas	99	225	276	637	383	637
Kentucky	132	911	405	1,683	405	1,683
Maryland	12	68	29	172	124	283
Michigan	0	67	12	148	76	279
Missouri	60	125	285	495	381	529
Montana	59	162	149	360	161	360
New Mexico	62	192	223	287	235	503
North Dakota	2	1	4	6	4	6
Ohio	400	2,966	1,501	6,919	1,823	8,411
Oklahoma	220	403	507	996	507	996
Pennsylvania:						
Anthracite	4,670	10,143	11,589	22,044	11,589	26,079
Bituminous	1,672	4,998	6,366	12,548	6,962	13,935
Tennessee	107	862	373	1,411	682	1,469
Texas	0	66	4	120	4	120
Utah	38	322	297	503	307	794
Virginia	7	180	23	307	27	373
Washington	227	671	532	1,223	532	1,223
West Virginia	681	2,305	3,202	5,102	3,311	5,102
Wyoming	33	80	120	87	363	201
Total	9,920	32,835	31,056	74,554	33,994	82,849

Fatal accidents in coal mines in the United States from 1896 to 1909.

State or Territory.	1896.	1897.	1898.	1899.	1900.	1901.	1902.	1903.	1904.	1905.	1906.	1907.	1908.	1909.
Alabama	28	38	45	40	37	41	50	57	84	185	96	4	108	129
Arkansas	......	......	......	......	......	18	13	......	......	8	13	10	14	a 12
Colorado	68	35	24	41	29	55	73	40	89	59	88	99	61	95
Georgia	......	......	......	......	......	......	......	......	......	......	......	......	......	2
Illinois	77	69	72	84	94	99	99	156	157	199	155	172	b 183	213
Indiana	28	16	22	16	18	24	24	55	34	47	31	53	45	50
Iowa	22	21	26	20	29	26	55	21	31	24	37	41	31	37
Kansas	12	6	17	16	22	26	27	36	a 16	36	31	32	b 27	b 35
Kentucky	6	12	6	7	17	21	19	25	19	31	40	32	39	34
Maryland	6	5	4	5	7	12	11	13	12	13	7	......	b 12	b 17
Michigan	......	......	......	a 4	10	6	6	8	7	8	6	7	5	9
Missouri	16	8	9	14	10	15	10	17	11	11	16	8	10	21
Montana	......	......	7	1	6	7	12	5	9	8	14	14	21	11
New Mexico	7	9	7	15	15	9	17	17	15	5	9	34	23	13
North Dakota	......	......	......	......	......	......	......	......	......	......	......	......	4	......
Ohio	41	40	52	57	68	72	81	114	118	131	127	153	113	115
Oklahoma (Indian Territory)	12	22	17	25	40	44	60	33	30	40	44	33	b 44	40
Oregon	......	......	......	......	......	......	......	......	......	......	......	......	......	1
Pennsylvania:														
Anthracite	502	423	411	461	411	513	300	518	595	644	557	708	678	567
Bituminous	180	150	199	258	265	301	456	402	536	479	477	806	572	506
Tennessee	22	10	19	20	10	53	226	26	28	29	33	......	34	31
Texas	......	......	......	......	......	......	......	......	......	......	......	......	......	4
Utah	3	3	3	......	209	10	8	7	9	7	7	6	8	16
Virginia	......	......	......	......	......	......	......	......	......	......	......	......	......	27
Washington	8	7	9	45	33	27	34	25	31	13	22	36	25	39
West Virginia	65	62	90	89	141	130	120	159	140	194	268	729	313	b 364
Wyoming	......	......	......	......	......	41	190	......	......	12	15	......	81	b 24
Total	1,103	936	1,039	1,218	1,471	1,550	1,891	1,734	1,971	2,183	2,093	3,127	2,451	2,412

a Six months only.

b Fiscal year.

QUANTITY OF COAL WASHED AT THE MINES IN 1909.

In the collection of the statistics of coal production during the last four years the schedules have included requests for information regarding the quantity of bituminous coal washed at the mines. The larger portion of the product so treated is slack coal used in the manufacture of coke, but considerable quantities of noncoking coal are also washed, notably in Illinois and Washington. In such cases the coal washed is usually screened nut used for domestic purposes. In 1909 the quantity of coal prepared for market or for coking by washing amounted to 16,541,874 short tons, the cleaned coal amounting to 14,443,147 short tons, and the refuse to 2,098,727 tons. In 1908, 13,660,478 short tons were washed at the mines, yielding 11,870,438 tons of cleaned coal and 1,790,040 tons of refuse. Alabama leads in the quantity of coal washed, with 5,863,396 tons, or about one-third of the total in 1909; practically all of this coal was used in the manufacture of coke. Illinois came second, with 4,064,085 tons, or nearly one-fourth of the total; and Pennsylvania came third, with 3,224,461 tons, or nearly one-fifth of the total.

In the report on the production of Pennsylvania anthracite, which will be found in the subsequent pages of this chapter and which is also published as a separate pamphlet, it is shown that 3,694,470 long tons, equivalent to 4,137,806 short tons, were recovered by washing from the old culm banks, against 3,646,250 long tons, or 4,083,800 short tons, in 1908. The quantity of coal recovered by the anthracite washeries is not included in the following table, which shows the quantity of bituminous coal washed at the mines in 1908 and 1909:

Bituminous coal washed at the mines in 1908 and 1909, with quantity of washed coal and of refuse obtained from it, by States and Territories, in short tons.

1908.

	Quantity of coal washed.	Quantity of cleaned coal.	Quantity of refuse.
Alabama	2,902,815	2,614,954	287,861
Arkansas	57,450	43,670	13,780
Colorado	449,320	336,123	113,197
Georgia	79,000	71,452	7,548
Illinois	3,768,112	3,202,264	565,848
Indiana	29,120	26,473	2,647
Kentucky	81,897	72,798	9,099
Missouri	74,104	55,576	18,528
Montana	286,517	214,729	71,788
New Mexico	450,114	384,778	65,336
Ohio	205,588	180,890	24,698
Oklahoma	64,812	58,252	6,560
Oregon	50,400	35,413	14,987
Pennsylvania	3,561,222	3,254,661	306,561
Tennessee	278,928	258,477	20,451
Virginia	30,872	29,745	1,127
Washington	1,098,879	859,942	238,937
West Virginia	191,328	170,241	21,087
Total	13,660,478	11,870,438	1,790,040

Bituminous coal washed at the mines in 1908 and 1909, with quantity of washed coal and of refuse obtained from it, by States and Territories, in short tons—Continued.

1909.

	Quantity of coal washed.	Quantity of cleaned coal.	Quantity of refuse.
Alabama	5,863,396	5,250,408	612,988
Colorado	425,561	318,939	106,622
Georgia	94,300	85,290	9,010
Illinois	4,064,085	3,466,097	597,988
Indiana	12,152	11,957	195
Kentucky	82,086	72,966	9,120
Michigan	176,537	151,793	24,744
Missouri	78,100	60,121	17,979
Montana	203,360	139,823	63,537
New Mexico	599,224	511,807	87,417
Oklahoma	33,280	28,852	4,428
Pennsylvania	3,224,461	2,985,512	238,949
Tennessee	302,632	271,565	31,067
Texas	5,850	5,000	850
Washington	1,048,177	778,038	270,139
West Virginia	328,673	304,979	23,694
Total	16,541,874	14,443,147	2,098,727

PRICES.

The following tables show the fluctuations in the average prices of coal in each State during the last six years, and the average prices for the total production of anthracite and bituminous coal since 1880. The averages are obtained by dividing the total product, including colliery consumption, into the total value. They show a general decline in values in 1909 as compared with the three years next preceding. There were only 6 States out of the 29 in which the prices for 1909 showed an advance over 1908. The most notable exception to the general decline was shown in the production of Washington, and it is observed that the average prices in that State have advanced each year since 1904. It should be stated, however, that a large part of the Washington product is mined by companies affiliated with or subsidiary to the railroad companies, which take all the output, and the placing of the value is simply a matter of bookkeeping and not indicative of market conditions.

Average price per short ton for coal at the mines since 1904, by States and Territories.

State or Territory.	1904.	1905.	1906.	1907.	1908.	1909.	Advance (+) or decline (−) in 1909.
Alabama	$1.20	$1.21	$1.34	$1.29	$1.26	$1.19	−$0.07
Arkansas	1.54	1.49	1.61	1.68	1.68	1.48	− .20
California	[a] 4.74	[a] 4.97	[a] 2.55	[a] 3.81	[a] 3.19	2.21	− .98
Colorado	1.31	1.22	1.26	1.40	1.41	1.33	− .08
Georgia	[b] 1.22	[b] 1.29	1.28	1.38	1.38	1.41	+ .03
Idaho	[c] 3.95	[c] 3.03	[c] 3.93	[d] 4.10	4.02	4.27	+ .25
Illinois	1.10	1.06	1.08	1.07	1.05	1.05	± .00
Indiana	1.11	1.05	1.08	1.08	1.06	1.02	− .04
Iowa	1.61	1.56	1.60	1.62	1.63	1.65	+ .02
Kansas	1.52	1.46	1.49	1.52	1.49	1.44	− .05
Kentucky	1.04	.99	1.02	1.06	1.01	.94	− .07
Maryland	1.19	1.14	1.19	1.20	1.17	1.11	− .02
Michigan	1.81	1.71	1.80	1.80	1.81	1.79	− .06
Missouri	1.63	1.58	1.63	1.64	1.64	1.65	+ .01
Montana	1.61	1.72	1.77	1.94	1.96	1.97	+ .01
New Mexico	1.31	1.33	1.34	1.46	1.37	1.29	− .08
North Carolina	([e])	([e])	....	....	....	....	....
North Dakota	1.43	1.34	1.54	1.61	1.63	1.56	− .07
Ohio	1.09	1.04	1.09	1.10	1.06	.99	− .07
Oklahoma (Indian Territory)	1.82	1.76	1.92	2.04	2.03	2.00	− .03
Oregon	2.18	2.58	2.66	2.34	2.74	2.69	− .05
Pennsylvania bituminous	.96	.96	1.00	1.04	1.01	.94	− .07
Tennessee	1.18	1.14	1.22	1.25	1.15	1.09	− .06
Texas	1.66	1.64	1.66	1.69	1.80	1.72	− .08
Utah	1.30	1.35	1.36	1.52	1.69	1.66	− .03
Virginia	.86	.88	.98	1.02	.91	.89	− .02
Washington	1.63	1.79	1.80	2.09	2.21	2.54	+ .33
West Virginia	.88	.86	.95	.99	.95	.86	− .09
Wyoming	1.30	1.31	1.31	1.56	1.62	1.55	− .07
Total bituminous	1.10	1.06	1.11	1.14	1.12	1.07	− .05
Pennsylvania anthracite	1.90	1.83	1.85	1.91	1.90	1.84	− .06
General average	1.26	1.21	1.24	1.28	1.28	1.20	− .08

[a] Includes Alaska.
[b] Includes North Carolina.
[c] Includes Nebraska.
[d] Includes Nebraska and Nevada.
[e] Included in Georgia.

Average price per short ton of coal in the United States for 30 years.

Year.	Anthracite.	Bituminous.	Year.	Anthracite.	Bituminous.
1880	$1.47	$1.25	1895	$1.41	$0.86
1881	2.01	1.12	1896	1.50	.83
1882	2.01	1.12	1897	1.51	.81
1883	2.01	1.07	1898	1.41	.80
1884	1.79	.94	1899	1.46	.87
1885	2.00	1.13	1900	1.49	1.04
1886	1.95	1.05	1901	1.67	1.05
1887	2.01	1.11	1902	1.84	1.12
1888	1.91	1.00	1903	2.04	1.24
1889	1.44	.99	1904	1.90	1.10
1890	1.43	.99	1905	1.83	1.06
1891	1.46	.99	1906	1.85	1.11
1892	1.57	.99	1907	1.91	1.14
1893	1.59	.96	1908	1.90	1.12
1894	1.51	.91	1909	1.84	1.07

IMPORTS AND EXPORTS.

The following tables have been compiled from official returns to the Bureau of Statistics of the Department of Commerce and Labor, and show the imports and exports of coal from 1905 to 1909, inclusive. The values given in both cases are considerably higher than the average "spot" rates by which the values of the domestic production have been computed.

The tariff from 1824 to 1843 was 6 cents per bushel, or $1.68 per long ton; from 1843 to 1846, $1.75 per ton; 1846 to 1857, 30 per cent ad valorem; 1857 to 1861, 24 per cent ad valorem; 1861, bituminous and shale, $1 per ton; all other, 50 cents per ton; 1862 to 1864, bituminous and shale, $1.10 per ton; all other, 60 cents per ton; 1864 to 1872, bituminous and shale, $1.25 per ton; all other, 40 cents per ton. By the act of 1872 the tariff on bituminous coal and shale was made 75 cents per ton, and so continued until the act of August, 1894, changed it to 40 cents per ton. On slack or culm the tariff was made 40 cents per ton by the act of 1872; was changed to 30 cents per ton by the act of March, 1883, and so continued until the act of August, 1894, changed it to 15 cents per ton. The tariff act of 1897 provided that all coals which contain less than 92 per cent fixed carbon, and which will pass over a half-inch screen, shall pay a duty of 67 cents per ton. Slack or culm was not changed by the act of 1897. Tons are all 2,240 pounds. Anthracite coal has been free of duty since 1870. During the period from June, 1854, to March, 1866, the reciprocity treaty was in force, and coal from the British possessions in North America was admitted into the United States duty free. A special act of Congress placed all the coal on the free list for one year from January 1, 1903, in order to relieve the shortage caused by the anthracite strike of 1902. Under the tariff act approved August 5, 1909, anthracite is practically excluded. It remains on the free list, but only as coal stores for American vessels, and must not be unloaded. The rate on bituminous coal is placed at 45 cents per long ton, and the rate on slack or culm is fixed at 15 cents per ton.

The exports consist of anthracite and bituminous coal, the quantity of bituminous being the greater in the last few years. They are made principally by rail over the international bridges and by lake and sea to the Canadian provinces. Exports are also made by sea to the West Indies, to Central and South America, and elsewhere.

The imports are principally from Australia and British Columbia to San Francisco, from Great Britain to the Atlantic and Pacific coasts, and from Nova Scotia to Atlantic coast points.

The total exports of coal from the United States during 1909 were 12,536,557 long tons, valued at $38,441,518, of which 2,842,714 long tons, valued at $14,141,468, were anthracite, and 9,693,843 long tons, valued at $24,300,050, were bituminous coal. The imports of anthracite amounted in 1909 to only 3,191 long tons, valued at $12,918, and those of bituminous coal to 992,579 long tons, valued at $3,076,502. In addition, 282,324 long tons of slack or culm (passing $\frac{1}{2}$-inch screen), valued at $552,031, were imported in 1909. From these figures it appears that the imports of anthracite coal into the United States are relatively of no importance. Most of the anthracite imported is to San Francisco and other points on the Pacific coast, being brought in principally as ballast in vessels coming for outgoing cargoes. The principal increase has been in imports of bituminous coal during the last five or six years. This has been due to the receipts of Nova Scotian coal at Everett, Mass., that fuel being used in the manufacture of coke in the retort-oven plant of the New England Gas and Coke Company at that place. Compared with the domestic production, the total quantity of coal imported into the United States is of little consequence, having for years averaged less than 1 per cent of the production.

Coal of domestic production exported from the United States, 1905–1909, in long tons.

Year.	Anthracite.		Bituminous and shale.	
	Quantity.	Value.	Quantity.	Value.
1905	2,229,983	$11,104,654	6,959,265	$17,867,964
1906	2,216,969	10,896,200	7,704,850	19,787,459
1907	2,698,072	13,217,985	10,448,676	26,972,908
1908	2,752,358	13,524,595	9,100,819	23,361,914
1909	2,842,714	14,141,468	9,693,843	24,300,050

Coal imported and entered for consumption in the United States, 1905–1909, in long tons.

Year.	Anthracite.		Bituminous and shale.	
	Quantity.	Value.	Quantity.	Value.
1905	34,241	$107,314	1,611,002	$3,903,765
1906	32,354	105,161	1,702,799	4,102,355
1907	9,897	40,971	2,103,711	5,397,222
1908	16,484	73,778	1,452,662	3,964,843
1909	3,191	12,918	[a] 1,274,903	3,628,533

[a] Includes 282,324 tons of slack or culm passing ½-inch screen.

WORLD'S PRODUCTION OF COAL.

As, according to the record made in coal production in 1908, the effect of the business depression was felt more severely in the United States than in other countries of the world, so in 1909 the recovery in the United States was characterized by a much larger increase in production than was exhibited in any other portion of the coal-producing world. The increase in production in the United States in 1909 over 1908—from 415,842,698 short tons in 1908 to 460,803,416 short tons in 1909—was nearly 45,000,000 short tons, or 10.8 per cent, while in both Great Britain and Germany the output of coal increased only about 1 per cent—in Great Britain from 292,887,144 short tons in 1908 to 295,427,229 short tons in 1909, and in Germany from 237,306,973 short tons in 1908 to 239,676,934 short tons in 1909. The increase in the United States in 1909 over 1908 was larger than the total production of any other country of the world, with the exception of Great Britain, Germany, and Austria-Hungary.

The year 1909 terminated a decade in which the United States has stood in the lead of the coal-producing countries of the world. Prior to 1899 Great Britain held the first place in this regard, but in that

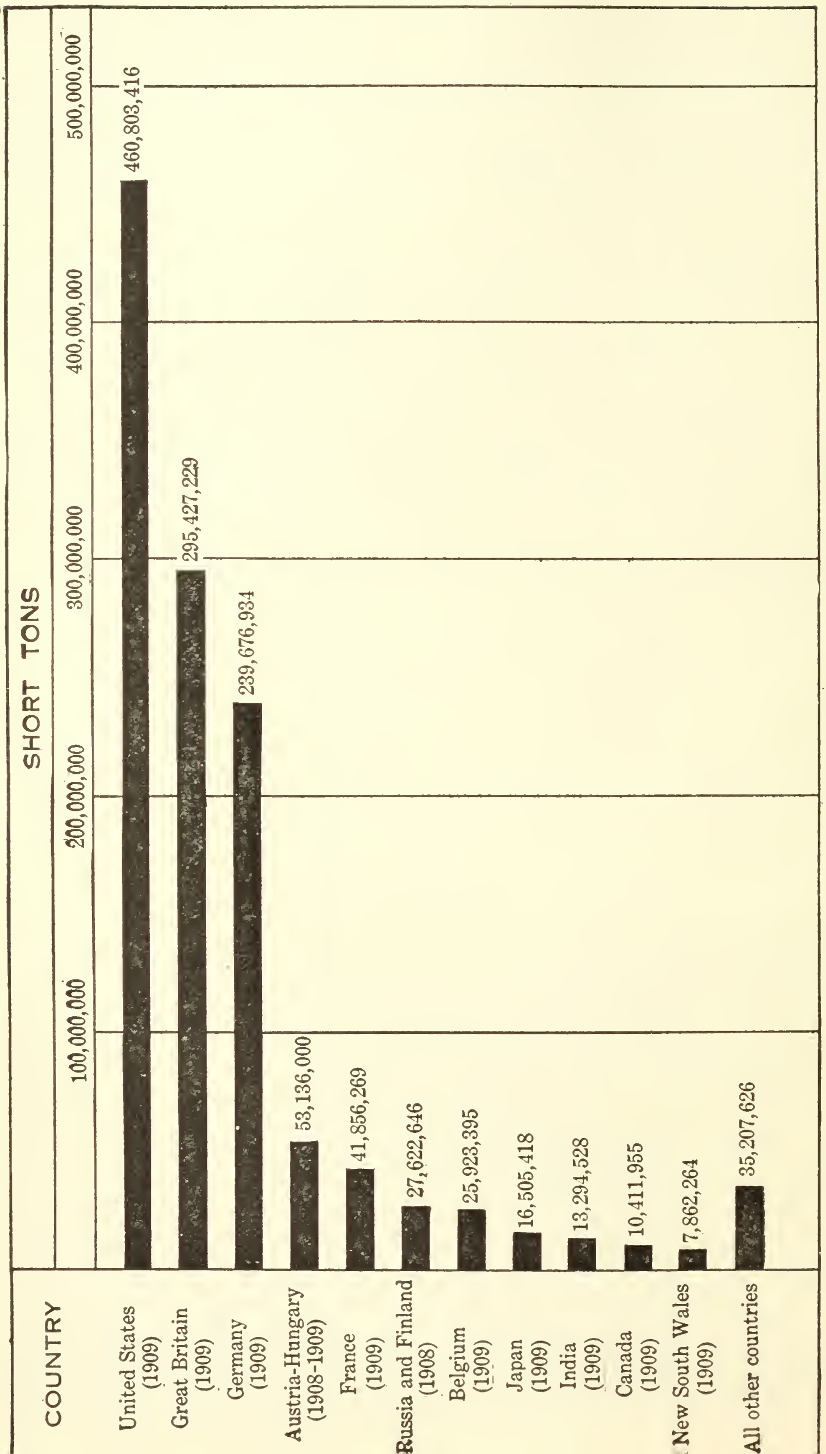

FIGURE 4.—World's production of coal.

year Great Britain was surpassed by the United States, and this country has maintained and increased its lead with each succeeding year. In 1909 the production of this country exceeded that of Great Britain by 165,376,187 short tons, or 56 per cent, and that of Germany by 221,126,482 short tons, or 92 per cent.

In the following table a statement is presented showing the coal production of the principal countries of the world in the years nearest to that under review for which the figures are obtainable. For the sake of convenience the quantities are expressed in the measurement customary in each country and are reduced for comparison to short tons of 2,000 pounds.

The world's production of coal.

Country.		Usual unit in producing country.	Equivalent in short tons.
United States (1909)	long tons	411,431,621	460,803,416
Great Britain (1909)	do	263,774,312	295,427,229
Germany (1909)	metric tons	217,433,488	239,676,934
Austria-Hungary [a]	do	48,204,663	53,136,000
France (1909)	do	37,971,758	41,856,269
Russia and Finland (1908)	do	25,059,100	27,622,646
Belgium (1909)	do	23,517,550	25,923,395
Japan (1909)	do	14,973,617	16,505,418
China (1908)	do	12,000,000	13,476,000
India (1909)	long tons	11,870,114	13,294,528
Canada (1909)	short tons	10,411,955	10,411,955
New South Wales (1909)	long tons	7,019,879	7,862,264
Spain (1908)	metric tons	4,118,276	4,539,576
Transvaal (1909)	long tons	2,957,512	3,312,413
New Zealand (1908)	do	1,860,975	2,084,292
Natal (1909)	do	1,786,583	2,000,973
Mexico (1908)	metric tons	1,024,579	1,129,393
Holland (1908)	do	908,201	999,230
Queensland and Victoria (1908)	long tons	810,294	907,529
Italy (1909)	metric tons	555,073	611,857
Sweden (1909)	do	246,808	272,056
Cape Colony (1908)	long tons	109,701	122,865
Tasmania (1909)	do	66,161	74,100
Other countries [b]	do	5,069,292	5,677,342
Total			1,227,727,680
Percentage of the United States			37.5

[a] Austria figures are for 1909; Hungary, 1908.
[b] Includes Turkey, Servia, Portugal, United States of Colombia, Chile, Borneo and Labuan, Peru, Greece, etc.

As a matter of historical interest the following table, giving the statistics of the production of coal in the more important countries of the world since 1868, is presented. In the forty-two years covered by this table the percentage of the total contributed by the United States increased from less than 15 per cent in 1868 to nearly 40 per cent in 1907, but decreased to 35.6 per cent in 1908. In 1909 the United States produced 37.53 per cent of the world's total.

World's production of coal, by countries, 1868–1909.

Year.	United States.		Great Britain.		Germany.	
	Long tons.	Short tons.	Long tons.	Short tons.	Metric tons.	Short tons.
1868	29,341,036	32,861,960	103,141,157	115,518,096	32,879,123	36,249,233
1869	29,378,893	32,904,360	107,427,557	120,318,864	34,343,913	37,864,164
1870	29,496,054	33,035,580	110,431,192	123,682,935	34,003,004	37,488,312
1871	41,861,679	46,885,080	117,352,028	131,434,271	37,856,110	41,736,361
1872	45,940,535	51,453,399	123,497,316	138,316,994	42,324,467	46,662,725
1873	51,430,786	57,602,480	128,680,131	144,121,747	46,145,194	50,875,076
1874	46,969,571	52,605,920	126,590,108	141,780,921	46,658,145	51,440,605
1875	46,739,571	52,348,320	133,306,485	149,303,263	47,804,054	52,703,970
1876	47,571,429	53,280,000	134,125,166	150,220,186	49,550,461	54,629,383
1877	54,019,429	60,501,760	134,179,968	150,281,564	48,229,882	53,173,445
1878	51,728,214	57,935,600	132,612,063	148,525,511	50,519,899	55,698,188
1879	60,808,749	68,105,799	133,720,393	149,766,840	53,470,716	58,951,464
1880	63,822,830	71,481,570	146,969,409	164,605,738	59,118,035	65,177,634
1881	76,679,491	85,881,030	154,184,300	172,686,416	61,540,485	67,848,385
1882	92,456,419	103,551,189	156,499,977	175,279,974	65,378,211	72,079,478
1883	103,310,290	115,707,525	163,737,327	183,385,806	70,442,648	77,663,019
1884	107,281,742	120,155,551	160,757,779	180,048,712	72,113,820	79,505,487
1885	99,250,263	111,160,295	159,351,418	178,473,588	73,675,515	81,227,255
1886	101,500,381	113,680,427	157,518,482	176,420,700	73,682,584	81,235,049
1887	116,652,242	130,650,511	162,119,812	181,574,189	76,232,618	84,046,461
1888	132,731,837	148,659,657	169,935,219	190,327,445	81,960,083	90,360,992
1889	126,097,779	141,229,513	176,916,724	198,146,731	84,973,230	93,640,500
1890	140,866,931	157,770,963	181,614,288	203,408,003	89,290,834	98,398,500
1891	150,505,954	168,566,669	185,479,126	207,736,621	94,252,278	103,913,136
1892	160,115,242	179,329,071	181,786,871	203,601,296	92,544,050	102,029,815
1893	162,814,977	182,352,774	167,325,795	184,044,890	95,426,153	105,207,334
1894	152,447,791	170,741,526	188,277,525	210,870,828	98,805,702	108,883,884
1895	172,426,366	193,117,530	189,661,362	212,320,725	103,957,639	114,561,318
1896	171,416,390	191,986,357	195,361,260	218,804,611	112,471,106	123,943,159
1897	178,776,070	200,229,199	202,129,931	226,385,523	120,474,485	132,762,882
1898	196,407,382	219,976,267	202,054,516	226,301,058	130,928,490	144,283,196
1899	226,554,635	253,741,192	220,094,781	246,506,155	135,824,427	149,719,766
1900	240,789,310	269,684,027	225,181,300	252,203,056	149,551,000	164,805,202
1901	261,874,836	293,299,816	219,046,945	245,332,578	152,628,931	168,217,082
1902	269,277,178	301,590,439	227,095,042	254,346,447	150,436,810	165,826,496
1903	319,068,229	357,356,416	230,334,469	257,974,605	162,457,253	179,076,630
1904	314,121,784	351,816,398	232,428,272	260,319,665	169,450,583	186,785,378
1905	350,645,210	392,722,635	236,128,936	264,464,408	173,796,674	191,576,074
1906	369,783,284	414,157,278	251,067,628	281,195,743	201,715,074	222,350,526
1907	428,895,914	480,363,424	267,830,962	299,970,677	205,727,665	226,773,605
1908	371,288,123	415,842,698	261,506,379	292,887,144	215,283,474	237,306,973
1909	411,431,621	460,803,416	263,774,312	295,427,229	217,433,488	239,676,934

World's production of coal, by countries, 1868-1909—Continued.

Year.	Austria-Hungary.		France.		Belgium.	
	Metric tons.	Short tons.	Metric tons.	Short tons.	Metric tons.	Short tons.
1868	7,021,756	7,741,486	13,330,826	14,697,236	12,298,589	13,559,194
1869	7,663,043	8,448,505	13,509,745	14,894,494	12,943,994	14,270,753
1870	8,355,945	9,212,429	13,179,788	14,530,716	13,697,118	15,101,073
1871	8,437,401	9,302,235	13,240,135	14,597,249	13,733,176	15,140,827
1872	8,825,896	9,730,550	16,100,773	17,751,102	15,658,948	17,263,990
1873	10,104,769	11,140,508	17,479,341	19,270,973	15,778,401	17,395,687
1874	12,631,364	13,926,079	16,907,913	18,640,974	14,669,029	16,172,604
1875	13,062,738	14,395,137	16,956,840	18,694,916	15,011,331	16,549,992
1876	13,000,000	14,327,300	17,101,448	18,854,346	14,329,578	15,798,360
1877	13,500,000	14,883,750	16,804,529	18,526,993	13,669,077	15,070,157
1878	13,900,000	15,324,750	16,960,916	18,699,410	14,899,175	16,426,340
1879	14,500,000	15,986,250	17,110,979	18,864,854	15,447,292	17,030,640
1880	14,800,000	16,317,000	19,361,564	21,346,124	16,886,698	18,617,585
1881	15,304,813	16,873,556	19,765,983	21,791,996	16,873,951	18,603,531
1882	15,555,292	17,149,709	20,603,704	22,715,584	17,590,989	19,394,065
1883	17,047,961	18,795,377	21,333,884	23,520,607	18,177,754	20,040,974
1884	18,000,000	19,845,000	20,023,514	22,075,924	18,051,499	19,901,778
1885	20,435,463	22,530,098	19,510,530	21,510,359	17,437,603	19,224,957
1886	20,779,441	22,909,334	19,909,894	21,950,658	17,285,543	19,057,311
1887	21,879,172	24,121,787	21,287,589	23,469,567	18,378,624	20,262,433
1888	23,859,608	26,305,218	22,602,894	24,919,691	19,218,481	21,188,375
1889	25,328,417	27,924,580	24,303,509	26,794,619	19,869,980	21,906,653
1890	27,504,032	30,323,195	26,083,118	28,756,638	20,365,960	22,453,471
1891	28,823,240	31,777,622	26,024,893	28,692,444	19,675,644	21,692,398
1892	29,037,978	32,014,371	26,178,701	28,862,018	19,583,173	21,590,448
1893	30,449,304	33,570,358	25,650,981	28,280,207	19,410,519	21,400,097
1894	31,492,000	34,704,184	27,459,137	30,273,699	20,458,827	22,555,857
1895	32,654,777	35,985,564	28,019,893	30,877,922	20,450,604	22,536,566
1896	33,676,411	37,111,405	29,189,900	32,167,270	21,252,370	23,420,112
1897	35,858,000	39,515,516	30,797,629	33,938,987	21,534,629	23,731,161
1898	37,786,963	41,652,569	32,356,104	35,656,426	22,075,093	24,326,752
1899	38,739,000	42,690,378	32,863,000	36,215,026	21,917,740	24,159,925
1900	39,029,729	43,010,761	33,404,298	36,811,536	23,462,817	25,856,024
1901	41,202,902	45,417,959	32,301,757	35,596,536	22,213,410	24,485,842
1902	39,479,560	43,518,310	30,196,994	33,286,146	22,877,470	25,217,835
1903	40,628,785	44,772,921	34,906,418	38,466,873	23,796,680	26,223,941
1904	41,014,182	45,209,933	34,167,966	37,663,349	22,761,430	25,089,924
1905	42,994,240	47,392,551	35,336,442	38,951,360	21,844,200	24,078,862
1906	45,568,434	50,230,085	34,313,645	37,823,931	23,610,740	26,026,119
1907	48,180,849	53,109,750	36,930,250	40,708,215	23,824,499	26,261,745
1908	49,280,786	54,322,210	37,622,556	41,471,343	22,679,300	24,999,392
1909	48,204,663	53,136,000	37,971,758	41,856,269	23,517,550	25,923,395

World's production of coal, by countries, 1868–1909—Continued.

Year.	Russia.		Japan.		Other countries.	Total.	Per cent of United States.
	Metric tons.	Short tons.	Metric tons.	Short tons.	Short tons.	Short tons.	
1868	430,032	473,895			1,147,330	222,248,430	14.79
1869	579,419	638,510			1,104,563	230,444,213	14.28
1870	667,806	735,922			1,063,121	234,850,088	14.07
1871	772,371	851,153			1,114,248	261,061,424	17.96
1872	1,037,611	1,143,447			1,268,115	283,590,322	18.14
1873	1,154,618	1,272,389			1,502,516	303,181,376	19.00
1874	1,270,889	1,400,520			2,708,756	298,676,379	17.61
1875	1,673,753	1,844,475			2,639,104	308,479,177	16.97
1876	1,795,146	1,968,251			2,597,143	311,674,969	17.09
1877	1,760,276	1,939,824			2,821,155	317,198,648	19.07
1878	2,483,575	2,738,141			3,176,050	318,523,990	18.19
1879	2,874,790	3,169,456			3,362,605	335,237,908	20.32
1880	3,238,470	3,570,413			3,621,342	364,737,406	19.60
1881	3,439,787	3,792,365			5,185,974	392,663,253	21.87
1882	3,672,782	4,049,242			6,128,631	420,347,872	24.63
1883	3,916,105	4,317,506	1,021,000	1,125,142	6,929,841	451,485,797	25.62
1884	3,869,689	4,266,332	1,159,000	1,277,218	7,367,309	454,443,311	26.44
1885	4,207,905	4,639,215	1,314,000	1,448,028	7,570,507	447,784,302	24.82
1886	4,506,027	4,967,895	1,402,000	1,545,004	9,082,815	450,849,193	25.21
1887	4,464,174	4,921,752	1,785,000	1,967,070	10,399,273	481,413,043	27.14
1888	5,187,312	5,719,011	2,044,000	2,252,488	11,493,176	521,226,053	28.52
1889	6,215,577	6,852,674	2,435,000	2,683,370	12,618,299	531,796,939	26.56
1890	6,016,525	6,633,219	2,653,000	2,923,606	13,025,637	563,693,232	27.99
1891	6,233,020	6,871,905	3,230,000	3,559,460	14,744,329	587,554,584	28.69
1892	6,816,323	7,514,996	3,228,000	3,557,256	14,998,633	593,497,904	30.22
1893	7,535,000	8,307,337	3,350,000	3,691,700	15,783,599	582,638,296	31.30
1894	8,629,000	9,509,158	4,311,000	4,750,722	18,197,510	610,487,368	27.97
1895	9,079,138	10,005,210	4,849,000	5,343,598	19,428,643	644,177,076	29.98
1896	9,229,000	10,170,358	5,019,690	5,531,698	20,866,748	664,001,718	28.92
1897	11,207,475	12,350,638	5,647,751	6,225,516	22,074,093	697,213,515	28.72
1898	12,307,450	13,562,810	6,761,301	7,572,657	24,797,873	738,129,608	29.80
1899	13,562,810	15,730,346	6,716,831	7,401,948	25,811,285	801,976,021	31.64
1900	16,151,557	17,799,016	7,429,457	8,187,262	27,684,964	846,041,848	31.88
1901	16,269,800	17,934,201	8,945,938	9,861,107	30,565,923	870,711,044	33.69
1902	15,259,674	17,090,835	9,701,682	10,691,254	37,907,163	889,474,934	33.91
1903	17,818,000	19,640,781	10,088,845	11,120,934	37,562,430	972,195,531	36.76
1904	[a] 19,318,370	21,294,639	10,772,240	11,874,240	43,332,409	983,385,935	35.78
1905	[a] 17,233,871	18,996,896	11,630,000	12,819,749	45,478,314	1,036,480,849	37.89
1906	21,613,800	23,857,961	12,980,103	14,307,968	47,898,532	1,117,848,143	37.05
1907	[a] 26,023,344	28,685,532	13,935,952	15,361,600	51,930,700	1,223,165,248	39.27
1908	[a] 25,059,100	27,622,646	14,825,363	16,341,998	58,276,756	1,169,071,160	35.57
1909			14,973,617	16,505,418	[b] 66,776,373	[c] 1,227,727,680	37.53

[a] These figures also include the production of Finland.
[b] This includes the output of Canada (1909, 10,411,955 short tons); India (1909, 13,294,528 short tons); New South Wales (1909, 7,862,264 short tons); Spain (1908, 4,539,576 short tons); South African Republic (1909, 3,312,413 short tons); New Zealand (1908, 2,084,292 tons); Sweden (1909, 272,056 tons); Italy (1909, 611,857 tons); Queensland (1908, 907,529 tons); also that of Holland, Natal, Cape Colony, Tasmania, Mexico, and Victoria; and of China, Turkey, Servia, Portugal, etc. (estimated), 7,840,000 tons.
[c] Latest available figures are used in making up totals for 1909.

COAL TRADE REVIEW.

It has been the practice in the preparation of the annual report on the production of coal to include reviews of the coal trade in some of the principal cities, and this custom has been followed in the present chapter. These reviews have been contributed, in whole or in part, by secretaries of chambers of commerce or other local authorities familiar with the coal trade of their respective communities. They will be found of interest as reflecting the conditions which have influenced the markets and the bearing they have had upon production. Acknowledgment for the services rendered is gratefully made and recognition by name is given for each contribution.

NEW YORK CITY.

The following review of the coal trade in New York City during 1909 has been prepared for this report by Mr. Frederick Hobart, associate editor of the Engineering and Mining Journal:

The coal trade of New York City may fairly be said to include not only the supply of the city itself and the immediate suburban districts, but that of a considerable extent of New England territory which draws its supplies by water from New York harbor shipping points. Taken as a whole, the trade in 1909 was disappointing. There was, of course, a large volume of business done, but the recovery from the depression of 1908, both in volume of trade and in prices, was much less than had been expected.

There was no material change in the methods of doing business. Complying with the provisions of the so-called Hepburn law, the two important anthracite carriers which operate their own mines gave up their selling business and disposed of their coal at the mine. The Delaware, Lackawanna and Western Railroad Company transferred its trade to the Delaware, Lackawanna and Western Coal Company, and the Delaware and Hudson Company turned over its business to the Hudson Coal Company. These changes, however, were more in form than in fact, and had no effect upon the trade.

COAL CONSUMPTION OF NEW YORK CITY.

The quantity of coal consumed in the city has never been determined until recently. During 1909 a compilation, made by Mr. R. W. Morris, published in the Black Diamond, gave approximate figures for 1908. Many of the figures are estimates, but it is believed that they make at least a fair approach to correctness. In 1909, according to the best judgment of authorities in the trade, there was an increase of 10 to 15 per cent over 1908. With due allowance for this increase and with the Morris figures as a basis, the consumption of coal in Greater New York in 1909 is shown approximately in the following table:

Consumption of coal in New York City in 1909, in long tons.

	Anthracite.	Bituminous.	Total.
Domestic; houses, etc	2,700,000		2,700,000
Flats and apartments	3,050,000		3,050,000
Office buildings and stores	800,000	500,000	1,300,000
Hotels, theaters, etc	1,425,000	100,000	1,525,000
Factories	400,000	1,800,000	2,200,000
Public utilities	2,100,000	1,600,000	3,700,000
Municipal departments	550,000	75,000	625,000
Blacksmiths and miscellaneous		75,000	75,000
Harbor shipping	375,000	150,000	475,000
Total	11,350,000	4,300,000	15,650,000

The quantity of bituminous coal used by office buildings, hotels, factories, public buildings, and gas and electric-light and power houses may seem rather large to those who do not know that bituminous coal is used in large quantities for mixing with anthracite in the furnaces. There is a popular impression that the use of bituminous coal is prohibited by city ordinances; but this is not the case, the prohibition applying only to the emission of smoke. If smokeless combustion can be accomplished by mixture with anthracite or by smoke-consuming devices, the use of bituminous coal is allowed; and, moreover, the ordinances are not strictly enforced, especially in the case of the large power houses on the river front.

The anthracite burned by office buildings, stores, large apartment houses, and all other buildings provided with central heating plants is largely of the small or steam sizes, so that the demand for those sizes in the city is large and steady and varies much less than any other with change of weather.

In addition to the city consumption there were in 1909 about 4,500,000 long tons of bituminous coal bunkered or supplied to seagoing steamships. This, of course, is not included in the city consumption, though it forms an important part of the coal carried to New York Harbor. Very little of it, in fact, enters the city, as it is usually loaded on shipboard from barges which are towed from the coal docks on the New Jersey shore of North River.

COAL DELIVERIES IN NEW YORK CITY.

As has been noted in previous reviews, the coal trade of New York City is largely a trade of day-to-day deliveries. Owing to the high cost of land, the coal dealers generally have little storage room and few large consumers are able to store up any considerable quantity. Deliveries in the borough of Manhattan are largely made from barges at the docks. In fact, it is doubtful whether the supply usually carried would last the city over a week or ten days. In the borough of Brooklyn much the same conditions exist, though the storage capacity is a little larger, both in yards and at factories. Facilities for coal delivery in Brooklyn will be much improved in 1910, owing to the completion of the Bay Ridge improvement and the new car ferry between Bay Ridge and Communipaw, by which coal from the Pennsylvania and the Lehigh Valley roads can be delivered at any point on the Long Island belt line which extends from Bay Ridge completely around Brooklyn to Hunters Point. This has already led to the establishment of a number of large distributing yards along the belt line, from which different sections of the borough can be served more conveniently and at less cost than heretofore.

The borough of Queens, made up of a number of detached towns and villages, is in rather a chaotic condition as to the supply and distribution of its coal, with a consequent wide difference in methods and rates. Thus, for instance, in the old village of Flushing, which has docks on a bay of East River within the harbor limits, domestic anthracite is delivered at 75 cents or $1 per ton less than in Jamaica and Far Rockaway, which receive their coal by rail. Storage yards are larger and more coal supplies are usually carried in Queens than in the other boroughs.

As a whole, it may be said that there is room for much improvement in the systems of delivery and distribution of coal to the myriad consumers of Greater New York.

Anthracite coal market.—The anthracite market in New York in recent years has not been a fluctuating one. A large part of the trade consists in deliveries to public-utility, electric-light, and power plants, which deliveries are usually covered by contract and vary little. The domestic consumption is affected by the weather, but not to an important extent. The condition of business makes some difference in the demand from factories, and that is the greatest variation.

The market opened in January, 1909, rather dull. The winter up to that date had been mild, and factory consumption had been rather below the average, so that the floating trade was light. There was a slight improvement but no important change manifest in the steam-coal sales. This continued up to March. Late in February the anthracite miners formulated and presented to the companies certain demands for changes in the wage agreement which was to expire March 31, with the implied threat of a strike in case these demands should not be granted. This hardly produced a ripple in the market. There was a general understanding that the companies held a strong position, that there were large stocks of coal accumulated to provide against a possible stoppage, and that there was no public opinion which would support the miners in a strike. The companies were so confident of their position that not only did matters continue as usual, but on March 31 the order was issued for the usual April discount. The only perceptible effect was a temporary scarcity of steam sizes, some companies having held back shipments of those sizes for use at the mines in case of a strike.

The event justified the early opinion. There was no strike, although the discussion over the mining agreement dragged on until early in May, when the matter was settled by the extension for three years of the old agreement, with a few unimportant modifications. This is not the place for comment, but it may be briefly said that the result proved the strong position of the companies, and was also a further proof of the justice and wisdom of the settlement made by the Anthracite Coal Strike Commission of 1902–3, which has stood the test of six years' working and is in effect for three years more.

Thereafter the local market continued quiet and undisturbed for several months. The stocks which had been piled up as provision against a possible strike were gradually worked off. From June on there was a better market, trade gradually improving. In August there was some delay in operations at many collieries, owing to short supplies of water which resulted from the long drought of the summer. This made steam sizes temporarily rather scarce for immediate local delivery. Otherwise there was little change in the market until well on in October, except that orders for coastwise shipments to New England points came in better than for two years before. This activity continued well through September.

There was no material change in the market thereafter until late in October, when weather signs indicated an early approach of cold weather, and dealers began to put in orders. Trade was brisk from that time on till near the close of the year. In the latter part of November cold weather set in and the retail trade was lively. Local dealers did well, so far as sales were concerned, until the end of the year; but their expenses were increased by bad weather and heavy snow, making wagon deliveries slow and difficult. The weather also caused delay on the railroads and to some extent in barge transfers from the harbor ports to the city docks. The year closed under this condition of large demand and slow delivery.

Throughout the year the schedule price of prepared or domestic sizes was unchanged (except for the summer discounts) at $4.75 for broken and $5 for egg, stove, and chestnut, all per long ton f. o. b. New York Harbor points. The discounts from these prices were 50 cents in April, 40 cents in May, 30 cents in June, 20 cents in July, and 10 cents in August, the full schedule being restored on September 1. Prices for the small or steam sizes did not vary much through the year. In February and March there was some scarcity, and again in October premiums of 10 or 15 cents were paid occasionally for pea coal; but this was not the rule. A fair average for the year is $3.10 to $3.25 for pea; $2.25 to $2.50 for buckwheat; $1.75 to $2 for No. 2 buckwheat or rice; $1.35 to $1.50 for barley. These prices are f. o. b. New York Harbor points, according to quality, the lower average being usually for washing coal. The larger part of this steam coal is sold and delivered on yearly contracts, so that fluctuations from month to month affect only about one-fourth of the sales.

Bituminous coal market.—The bituminous market opened in January rather dull, and was disappointing to dealers. Eastern trade had not opened and the local trade was small. Good Clearfield sold at $2.45, f. o. b. New York Harbor, with as high as $2.65 paid for better grades. Current business improved a little toward the end of the month, but fell off again as February opened. In that month the prices declined a little, and what trade was going was taken quite freely at $2.40 to $2.45, f. o. b. harbor points, for good steam coal, with lower grades selling down to $2.25. About the middle of the month there was a temporary scarcity of gas slack, and premiums of 10 and 15 cents per ton were paid for some available lots.

In March current business was still irregular. A good deal of coal was sold, but orders came in bunches and were chiefly for the lower-priced coals, which were to be had at $2.20 to $2.30, New York Harbor, good Clearfield selling up to $2.40 and $2.50 per ton. The discussion of yearly contracts began to be active, but consumers generally were inclined to hold back and to insist on lower prices. Some contracts were taken at 25 cents per ton under the low prices of 1908. Producers protested, but could not insist, especially as it began to be generally known that West Virginia coal was being extensively offered through New England territory at low prices. Good Pocahontas and New River coals were placed at about $2.15 per ton, f. o. b. Lamberts Point and Newport News. These offers were disturbing to the New York City trade, and a number of contracts were let at the low prices.

The strain put upon coal operators by the competition will be realized when it is stated that the tidewater prices paid on contract and on current business for a large part of the year were equivalent to 90 cents to $1 per ton at the mine for good steam coal, and ranged up to $1.50 for only a few high-grade coals, and that gas coal realized 55 to 65 cents per ton for slack and 65 to 70 cents for run-of-mine at the mines.

Contract closing was slow; some large consumers held back nearly all through April, and a few contracts dragged over into May. Local trade, however, improved in May, and in June it showed quite a marked improvement. Sales were larger and there was a small improvement in prices, fair grades of Clearfield selling at $2.40 to $2.50 per ton, f. o. b. New York Harbor, and special grades of coal selling at $2.60 to $3 per ton. In June New England buyers began to realize that their bins were getting empty and that their supplies must be replenished. West Virginia coal, however, prevented any greater advance in price.

July trade was larger in quantity but still irregular, orders coming in slowly one week and with a rush the next. This irregular and bunchy trade, in fact, was characteristic of nearly the whole season. The harbor prices quoted for June continued to be current through July and August, though in August there was a further improvement in the quantity of coal sold. In September there was an increased demand for deliveries from local electric-light companies and from power houses, which were preparing for the expected extra demands upon them for the week of the Hudson-Fulton celebration.

In September operators began to be troubled by short supply of cars, a condition which had been almost unknown for a year and a half. In October this shortage grew worse, and it was at times hard to get coal through as fast as it was needed. This fact and the usual rush to buy winter coal for the shoal-water ports in the eastern New England States before ice could interfere with navigation brought about an advance of 5 or 10 cents in New York Harbor prices. Buyers, however, continued to adhere to their preference for the lower-priced coals.

In November the call for shipments to the New England States subsided, but local trade improved and good sales were made. Car shortage continued to trouble the trade, and there were days at a time when the harbor docks were almost bare. A further advance of 10 cents was realized toward the end of the month, but this was lost in early December when the closing of Lake navigation threw larger shipments to the seaboard and left more cars free for that trade.

December was rather an eventful month in the trade. The call for coal for shipment to the New England States declined, of course, but local demand continued good, and some large consumers who had declined to make contracts earlier in the year, preferring to take the chances of the open market, were active and insistent buyers. The temporary improvement in car supply disappeared, and it was difficult for shippers to get even half the cars they needed. This trouble was intensified during the latter part of the month by severe cold and heavy snows, which blocked the railroads and made transportation slow. The storms also caused trouble in the movement of barges from the docks and made local deliveries slow, so that life for the coal dealer was temporarily a hard struggle. There was a special scarcity of gas coal, and consumers were dependent on day-to-day deliveries to an embarrassing extent. The year closed under these conditions.

Taken as a whole, the local bituminous trade of the year was disappointing. The recovery from depression was less than had been expected; prices were generally low, and in the last quarter of the year transportation troubles were much in evidence. One feature of the trade, which is hardly yet fully understood or appreciated outside, was the increased disposition of large consumers to deal directly with producers wherever possible. This is steadily increasing and may in time—possibly in a short time—lead to the practical elimination from the trade of the commission houses, which have held so large a place in the past.

Coastwise trade.—The coastwise trade opened moderately. Vessels were not in large supply and rates were fair, at 75 cents per ton from New York to points around Cape Cod and 45 cents to Providence and to Long Island Sound ports. As boats began to come out of winter quarters rates gradually declined to 60 cents to points beyond the Cape and 35 cents to the Sound. In May there was a temporary advance, owing to stormy and foggy weather, but thereafter the supply of boats was greater than the business, and in June cargoes were taken at 60 to 65 cents around Cape Cod and 45 to 40 cents to Providence and the Sound. By September these rates had fallen to 55 cents and to 30 to 35 cents, respectively, which was the lowest point. In October there was a small advance, owing to a demand for vessels for the shoal-water or ice-making ports. In November these rates were 65 and 40 cents, and early in December 75 and 45 cents, respectively. In the last half of December coastwise trade was tied up by severe storms in which quite a number of coal boats were wrecked.

The bituminous trade remains largely with the sailing vessels, but the greater part of the anthracite is now carried by the barges owned by the coal companies.

On the whole the year was a poor one, owing to the general oversupply of boats and the competition for charters, in consequence of which conditions the loading and discharging clause was not generally insisted on. A part of the depression was due to the diversion to the Poughkeepsie Bridge line of a considerable trade which formerly went by way of the Sound ports.

The shipments of coal by water from New York Harbor coal-delivery points for the last three years are reported as follows:

Shipments of coal by water from New York Harbor points, 1907–1909, in long tons.

	1907	1908	1909
Anthracite	16,753,914	15,069,981	14,418,292
Bituminous	11,691,101	10,247,014	10,549,974
Total	28,445,015	25,316,995	24,968,266

As compared with 1908, the shipments in 1909 showed a decrease of 651,689 tons of anthracite and an increase of 302,960 tons of bituminous coal, the total decrease being 348,729 tons. No exact division of these shipments can be made from the records, but a fair estimate is that between 60 and 70 per cent of the total was made up by barge deliveries to city and neighboring wharves, the remainder going chiefly to New England ports.

BOSTON, MASS.

Mr. Robert C. Coffin, secretary of the fuel supply committee of the Boston Chamber of Commerce, has furnished the following review of the coal trade of that city in 1909:

Receipts and shipments.—The total tonnage of coal received in New England from all points for the calendar year 1909 amounted to about 25,350,000 long tons. Boston alone received 5,429,967 long tons, or about 21 per cent of the total tonnage. Of the Boston receipts 1,706,659 long tons were anthracite and 3,723,308 tons were bituminous. The receipts for 1909 were practically the same as for 1908. There was, however, a decrease of 142,412 long tons in the receipts of foreign coal and a decrease in the receipts of anthracite coal of 69,742 tons, but an increase of 192,082 tons in the receipts of bituminous coal. This made a net decrease for the year 1909 of 20,072 long tons.

A considerable portion of the coal received at Boston is forwarded over the railroads to interior points. In 1909 244,345 long tons, or about 14 per cent of the anthracite tonnage, and 1,139,278 tons, or about 31 per cent of the bituminous tonnage, received at Boston was forwarded to interior New England points. The net receipts for local consumption amounted to 1,462,314 tons of anthracite and 2,584,030 tons of bituminous. The tonnage of anthracite coal received during the six months from April to September amounted to 871,341 long tons, and for the other six months 835,318 tons. This is significant, for it shows the effect of the policy of making a summer reduction in the price of anthracite coal, as more than 50 per cent of the receipts of domestic coal were purchased during the period of low prices. It is claimed that the increasing consumption of gas for domestic purposes is responsible for a falling off in the consumption of anthracite coal, particularly during the summer months.

The following table shows the receipts both of anthracite and of bituminous coal at Boston, by months, for 1909, the quantities forwarded to interior points, the net receipts for local consumption, and the totals for 1909 as compared with the three preceding years:

Receipts and shipments of coal at and from Boston in 1909, by months, in long tons.

Month.	Receipts from all points.		Shipments to New England points.		Net receipts (for local consumption).	
	Anthracite.	Bituminous.	Anthracite.	Bituminous.	Anthracite.	Bituminous.
January	99,855	254,644	19,342	111,613	80,513	143,031
February	93,005	243,611	14,022	80,366	78,983	163,245
March	169,681	367,213	17,452	122,244	152,229	244,969
April	193,560	298,210	44,042	87,136	149,518	211,074
May	175,497	306,448	30,018	67,623	145,479	238,825
June	144,401	300,662	23,386	70,893	121,015	229,769
July	107,573	315,447	14,981	102,747	92,592	212,700
August	119,946	384,881	11,589	125,482	108,357	259,399
September	130,364	289,607	14,023	101,395	116,341	188,212
October	181,125	395,430	19,708	96,188	161,417	299,242
November	160,782	262,605	16,450	100,618	144,332	161,987
December	130,870	304,550	19,332	72,973	111,538	231,577
Total, 1909	1,706,659	3,723,308	244,345	1,139,278	1,462,314	2,584,030
1908	1,776,401	3,673,638	255,984	1,130,674	1,520,417	2,542,964
1907	2,053,288	3,831,636	281,633	854,347	1,771,655	2,977,289
1906	1,659,679	3,517,916	197,690	1,370,477	1,461,989	2,147,439

As previously stated, the receipts of foreign coal showed a decrease of 142,412 long tons. This coal is almost exclusively from the bituminous mines of Nova Scotia and is delivered to the by-product coking plant at Everett, a suburb of Boston. The quantity of Nova Scotia coal received at this plant has shown a gradual decline since

1906, when it amounted to 658,072 tons. This is said to be due to increasing quantities of West Virginia coal displacing the Nova Scotia product. Before the passage of the Payne-Aldrich tariff bill the duty on the larger sizes of Canadian coal was 67 cents per ton. This has now been reduced to 45 cents per ton. It is rather early to ascertain what effect, if any, this will have on the consumption of Canadian coals. Below is given a table showing the receipts of domestic and foreign coals at the port of Boston for a series of seven years.

Receipts of coal at Boston, Mass., for seven years, in long tons.

Year.	Domestic.				Foreign.		Total.
	By water.		By rail.				
	Anthracite.	Bituminous.	Anthracite.	Bituminous.	Anthracite.	Bituminous.	
1903	2,042,512	2,078,499	109,033	185,330	22,432	1,226,134	5,663,940
1904	1,961,785	2,397,885	40,994	117,605	....	550,383	5,068,652
1905	1,941,478	2,757,186	35,920	41,104	....	608,471	5,384,159
1906	1,630,674	2,772,593	29,005	87,251	....	658,072	5,177,595
1907	2,016,252	3,196,057	37,036	89,927	....	545,652	5,884,924
1908	1,733,112	3,240,562	43,289	62,367	....	370,709	5,450,039
1909	1,668,126	3,393,423	38,533	101,588	....	228,297	5,429,967

Retail prices of anthracite coal.—Below is given a table showing the retail prices of anthracite coal for 1909. The summer prices went into effect on May 1, 1909, and remained unchanged until September 4, when all sizes were increased 50 cents per ton, with the exception of pea, which was advanced 25 cents per ton. The year 1909 was unlike previous years in that the change from the summer to the winter prices has usually been made by advances of 10 cents per month.

Retail prices per ton of anthracite coal at Boston in 1909, by kinds.

Kind.	May 1.	September 4.	Kind.	May 1.	September 4.
Furnace	$6.25	$6.75	Pea	$5.25	$5.50
Egg	6.75	7.25	Shamokin	7.25	7.75
Stove	7.00	7.50	Franklin	8.25	8.75
Nut	7.00	7.50			

Coastwise freight rates.—The coastwise freight rates in 1909 were materially higher than in 1908, when the rates reached the lowest point in the history of the coal-carrying trade, some cargoes from Hampton Roads being carried as low as 40 cents per ton. From Hampton Roads and Philadelphia the minimum rate in 1909 was 60 cents per ton and the maximum rate was 90 cents per ton, as against rates ranging from 50 cents to $1 in 1908. The range of rates from Baltimore in 1909 was from 70 cents to $1 per ton, as against 50 to 85 cents in 1908.

Coal freights to Boston during 1908.

From—	Minimum.		Maximum.	
	Rate.	Date.	Rate.	Date.
New York	[a] $0.50–$0.55		$0.85	February 15.
Philadelphia	.50	July 1–October 30	1.00	January 1–31.
Baltimore	.50	August 10–November 15	.85	January 15.
Norfolk and Newport News	.50	June 15–December 15	.80	January 25.

[a] Fifty to fifty-five cents was season rate on anthracite coal-carrying railroad transportation from New York, and 75 cents from Philadelphia. Sixty cents was the minimum rate on sail (sailing vessels) tonnage from New York to Boston.

Coal freights to Boston during 1909.

From—	Minimum.		Maximum.	
	Rate.	Date.	Rate.	Date.
New York	[a] $0.50–$0.55		$0.85	December 10–31.
Philadelphia	.60	April 1–October 31	.90	December 20.
Baltimore	.70	do	1.00	December 15.
Norfolk and Newport News	.60	do	.90	December 20–31.

[a] Fifty to fifty-five cents was season rate on anthracite coal-carrying railroad transportation from New York, and 75 cents from Philadelphia. Fifty cents was the minimum rate on sail (sailing vessels) tonnage from New York to Boston.

The year 1909 was marked by the addition of two modern steamers, built especially for the coal-carrying trade, each having a capacity of about 6,700 tons. This makes in all five modern coal steamers now engaged exclusively in carrying soft coal from Hampton Roads and Baltimore to Boston, having a total capacity of about 35,000 tons.

New England coal consumption, 1909.—During 1909 the fuel supply committee of the Boston Chamber of Commerce compiled a report on the Buying and Handling of Steam Coal in New England, giving a very comprehensive survey of the coal-rate situation, valuable tables of coal analyses, and, among other things, a table showing the total consumption of coal in New England in 1908, which was probably the first accurate statement of this tonnage ever compiled. Below is given a table showing similar figures for 1909.

Coal tonnage discharged at New England ports, 1909, in long tons.

Port.	Anthracite.	Bituminous.	Total.
Connecticut:			
Bridgeport	370,665	350,708	721,373
New Haven	200,000	1,003,507	1,203,507
New London	57,558	172,675	[a] 230,233
Norwich (including Allyns Point)	98,588	295,764	[a] 394,352
Hartford	108,000	168,750	[a] 276,750
Rhode Island:			
Newport	69,807	62,830	[b] 132,637
Providence	520,955	1,843,294	[b] 2,364,249
Pawtucket	114,151	180,449	[b] 294,600
Massachusetts:			
Fall River	243,602	588,602	[b] 832,204
New Bedford	632,484	406,061	[b] 1,038,545
Taunton	55,627	91,582	[b] 147,209
Boston	1,668,126	3,621,720	5,289,846
Lynn	56,344	225,000	281,344
Salem	234,820	187,962	422,782
Beverly	30,000	70,000	[a] 100,000
Gloucester	29,000	11,500	40,500
Newburyport (including Haverhill)	60,000	270,000	330,000

[a] Figures for 1908. [b] Figures furnished by U. S. engineer office, Newport, R. I.

Coal tonnage discharged at New England ports, 1909, in long tons—Continued.

Port.	Anthracite.	Bituminous.	Total.
New Hampshire:			
Portsmouth	164,633	328,046	492,679
Maine:			
Kennebunkport	1,900	7,750	9,650
Saco	20,000	22,800	42,800
Portland	250,000	1,221,885	1,471,885
Bath	30,000	25,000	55,000
Gardiner	17,200	13,100	30,300
Hallowell	12,000	4,000	16,000
Augusta	16,000	9,000	[a] 25,000
Wiscasset	1,000	2,500	3,500
Belfast	7,900	2,900	10,800
Rockland	30,000	60,000	90,000
Searsport	21,320	202,054	223,374
Bangor	46,365	231,826	278,191
Calais	10,000	50,000	60,000
Eastport	5,400	11,616	17,016
All other New England ports (estimated)	150,000	200,000	350,000
Total	5,333,445	11,942,881	17,276,326
Total tonnage received all rail	3,666,253	4,408,221	8,074,474
Total New England receipts, 1909	8,999,698	16,351,102	25,350,800

[a] Figures for 1908.

PHILADELPHIA, PA.

The following review of the coal trade of Philadelphia has been prepared for this report by Mr. Samuel R. Kirkpatrick:

During the early part of 1909 there was some apprehension of labor trouble at the anthracite mines. This was prior to April 1, and in March large supplies of hard coal were stored up by the dealers and consumers in anticipation of a suspension of operations pending a settlement of the wage agreement. The buying of large quantities of anthracite coal in March was something unusual as for several years past a reduction of 50 cents a ton had been made effective April 1, and buying was generally postponed until after that date. All differences between the coal companies and the miners were amicably settled, however, and no strike took place. But the large quantities of anthracite bought in March unsettled the spring trade and business became very dull. As a whole the anthracite trade in Philadelphia and vicinity in 1909 was dull, and it was not until toward the end of the year that buying became normal. The production of anthracite was not so large as in 1908. This was due to the falling off in business and to the scarcity of water at the mines. The drought was more severe than in 1908, and many mines were compelled to suspend operations for days at a time. The large coal companies, such as the Philadelphia and Reading Coal and Iron Company, the Susquehanna Coal Company, the Lehigh Valley Coal Company, and the Lehigh Coal and Navigation Company, had to haul water in tank cars to keep their mines in operation. In the first few months of the year the mines were worked to their full capacity as the companies were anxious to have large stocks on hand in order that, in case of trouble with the miners, they would be in a position to keep the trade supplied.

For the year 1909 the total shipments of anthracite coal from the mines amounted to 61,969,885 long tons, against 64,665,014 tons in 1908 and 67,109,393 tons in 1907. This tonnage is only what was forwarded from the mines and does not include coal used at and around the coal plants. Although the total shipments for the year 1909 were less than for 1908, there was one month, March, when the largest tonnage in the history of the trade was shipped. In that month 6,332,474 long tons of coal were forwarded from the mines. The previous record was in May, 1908, when the shipments amounted to 6,088,116 tons. The shipments to Philadelphia in 1909 decreased 116,308 tons, as compared with 1908. Some of the individual operators cut prices during the summer months, the concessions at times being from 25 to 50 cents below the circular.

Early in March, as has already been noted, many of the dealers as well as the large consumers became anxious and placed their orders for immediate delivery. This caused a good demand, and as there was to be a reduction of 50 cents per ton on domestic sizes on April 1, the coal companies did everything in their power to fill all orders before the month expired. In April, and in fact, during May, June, July, August, and September, the anthracite coal trade was extremely dull, but with the general improvement in business in the latter months of the year the demand increased and circular prices were generally maintained.

The local consumption of bituminous coal is steadily increasing, notwithstanding the efforts of the civic associations to prevent the use of this fuel within the city limits. In 1909 the consumption of bituminous coal in Philadelphia amounted to 2,292,143 long tons, an increase of 358,036 tons. During 1909 the coal companies not only increased their storage facilities but added many improvements for the speedy coaling of vessels alongside the coal docks. By September nearly all the manufacturing establishments in Philadelphia and vicinity were working to their full capacity. This created a better demand for bituminous fuel. At the time of the big anthracite coal strike in 1902 many of the manufacturing plants in Philadelphia began using bituminous coal and few have returned to anthracite. It is thought, however, that the city council will take some action on the burning of soft coal within the city limits.

Although the stock of coal on hand in the yards and plants of the coal producing companies at the beginning of 1909 was large, the demand was good and before the spring circular prices went into effect considerable depletion was made. However, after April, with the fear of a suspension removed, stocks began to accumulate and remained large until November. The severe weather of the latter part of the year caused a big demand and at the end of the year the amount of anthracite on hand was somewhat less than at the beginning. On April 1 the usual reduction of 50 cents per ton was made and each month thereafter the price advanced 10 cents per ton until September, when the full circular prices were restored. The reduction was made on domestic sizes only, as the demand for pea and other small sizes is fully equal to, if not greater than, the supply. The larger anthracite coal companies are endeavoring to create a market for hard coal in the cities bordering on the Great Lakes. In 1909 these companies made a determined effort to secure this western trade, but comparatively little headway has been made.

The shipments for export of anthracite from the port of Philadelphia in 1909 were 64,499 long tons, an increase of 8,676 tons; the shipments for coastwise and harbor trade fell off 273,892 tons, the total shipment being 1,764,219 tons. During the summer months the shipment of bituminous coal by water was very light.

The local consumption of bituminous coal was 2,292,143 long tons, an increase of 358,036 tons. This increase was brought about by the general starting up of manufacturing establishments during the latter half of the year.

The following table shows the average range of retail prices of anthracite and bituminous coal during 1909, by months:

Average prices for anthracite and bituminous coal at Philadelphia in 1909, by months, per long ton.

Month.	Prepared sizes.	Pea.	Buckwheat.	Rice.	Bituminous.
January	$6.75–$7.00	$4.75	$3.35–$3.75	$2.75–$3.10	$3.75–$4.00
February	6.75– 7.00	4.75	3.35– 3.75	2.75– 3.10	3.75– 4.00
March	7.00	4.75	3.35– 3.75	2.75– 3.10	3.75– 4.00
April	6.00– 6.50	$4.50– 4.75	3.35– 3.75	2.75– 3.10	3.75– 4.00
May	6.25– 6.60	4.50– 4.75	3.35– 3.75	2.75– 3.10	3.50– 4.00
June	6.35– 6.70	4.50– 4.75	3.35– 3.75	2.75– 3.10	3.50– 4.00
July	6.40– 6.80	4.40– 4.75	3.35– 3.75	2.75– 3.10	3.50– 4.00
August	6.50– 6.90	4.40– 4.75	3.35– 3.75	2.75– 3.10	3.50– 4.00
September	6.50– 7.00	4.50– 4.75	3.35– 3.75	2.75– 3.10	3.75– 4.00
October	6.50– 7.00	4.75	3.35– 3.75	2.75– 3.10	3.75– 4.00
November	6.75– 7.00	4.75	3.35– 3.75	2.75– 3.10	3.75– 4.00
December	6.75– 7.00	4.75	3.35– 3.75	2.75– 3.10	3.75– 4.00

The production of anthracite coal during 1909 was fairly steady, although the drought caused considerable difficulty in operating all the mines. The following table shows the shipments during each month of 1909, as compared with 1908:

Anthracite shipments in 1908 and 1909, by months, in long tons.

Month.	1908	1909	Month.	1908	1909
January	5,618,339	5,183,345	August	4,599,093	4,198,273
February	4,503,756	4,576,004	September	5,211,047	4,416,120
March	4,766,158	6,332,474	October	5,977,497	5,579,759
April	5,987,221	5,891,176	November	5,839,491	6,027,800
May	6,088,116	5,063,873	December	5,827,938	5,775,438
June	5,704,952	4,904,858			
July	4,541,506	4,020,765	Total	64,665,014	61,969,885

The following table shows the prices of the various sizes of anthracite at the mines during the year 1909, by months:

Prices of anthracite at the mines for Philadelphia delivery in 1909, per long ton, by months.

Month.	Broken.	Egg.	Stove and chestnut.	Pea.	Buckwheat.
1909.					
January	$3.00–$3.50	$3.75	$3.75	$2.00	$1.25–$1.50
February	3.00– 3.50	3.75	3.75	$2.00– 2.25	1.25– 1.50
March	3.00– 3.50	3.75	3.75	2.00– 2.25	1.25– 1.50
April	3.00– 3.50	$3.25– 3.75	$3.25– 3.75	2.00	1.25– 1.50
May	3.00– 3.25	3.25– 3.35	3.35	1.75– 2.00	1.10– 1.50
June	3.00– 3.20	3.25– 3.45	3.45	1.75– 2.00	1.10– 1.50
July	3.00– 3.30	3.25– 3.55	3.35– 3.55	1.75– 2.00	1.10– 1.50
August	2.90– 3.40	3.25– 3.65	3.35– 3.65	1.75– 2.00	1.10– 1.50
September	2.90– 3.50	3.25– 3.75	3.45– 3.75	1.75– 2.00	1.10– 1.50
October	3.00– 3.50	3.25– 3.75	3.75	2.00	1.10– 1.50
November	3.00– 3.50	3.25– 3.75	3.75	2.00	1.10– 1.50
December	3.00– 3.50	3.25– 3.75	3.75	2.00	1.10– 1.50

There is a steady increase in the export of anthracite coal. During 1909 the exports of hard coal from the port of Philadelphia amounted to 64,499 tons, an increase of 8,676 tons over 1908. The largest shipments of anthracite from Philadelphia were to Canada, that country taking 27,239 tons, valued at $99,741. There were shipments to Cuba amounting to 25,528 tons; to Newfoundland, 8,425 tons; to Bermuda, 2,147 tons; and to the British West Indies, 148 tons. Ten tons were shipped to Italy, 350 tons to Norway, 102 tons to Spain, and 550 tons to Santo Domingo. The value of the anthracite exported was $261,784.

There was no change in freight rates for local delivery of anthracite during the year. The charges per ton, which vary according to the region from which the shipment is made and according to the size of coal, were as follows:

Freight rates per long ton on anthracite from coal regions to Philadelphia, Pa.

Region.	Prepared sizes.	Pea.	Buckwheat.
Schuylkill	$1.70	$1.40	$1.25
Lehigh	1.75	1.45	1.30
Wyoming	1.80	1.50	1.35

Through the courtesy of the officers of the Pennsylvania Railroad Company, the Philadelphia and Reading Railway Company, the Lehigh Coal and Navigation Company, and the Baltimore and Ohio Railroad Company, data have been furnished from which the following table has been compiled. It shows the distribution of coal at Philadelphia for the export trade, the coastwise and harbor trade, and the Philadelphia local trade:

Distribution of coal at Philadelphia, Pa., in 1908 and 1909, in long tons.

Destination.	1908		1909	
	Anthracite.	Bituminous.	Anthracite.	Bituminous.
Export	55,823	741,891	64,499	767,284
Coastwise and harbor	2,038,111	4,257,171	1,764,219	4,114,620
Local	4,106,985	1,934,107	3,990,677	2,292,143
Total	6,200,919	6,933,169	5,819,395	7,174,047

The price circular of the Philadelphia and Reading Coal and Iron Company, which is the same as that of other companies, is as follows:

Circular prices for anthracite coal at the mines in 1907, 1908, and 1909.

Size.	1907			1908		1909	
	January.	April.	September.	April.	September.	April.	September.
Lump	$3.50	$3.25	$3.50	$3.50	$3.50	$3.50	$3.50
Steamboat	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Broken	3.50	3.00	3.50	3.00	3.50	3.00	3.50
Egg	3.75	3.25	3.75	3.25	3.75	3.25	3.75
Stove	3.75	3.25	3.75	3.25	3.75	3.25	3.75
Chestnut	3.75	3.25	3.75	3.25	3.75	3.25	3.75
Pea	1.75	1.75	2.00	2.00	2.00	2.00	2.00
Buckwheat	1.25	1.25	1.50	1.50	1.50	1.50	1.50

The bituminous-coal trade was somewhat erratic, although the better quality of coal brought a fair price throughout the year.

The export shipments of bituminous coal in 1909 showed an increase of 25,393 long tons over 1908, the total shipments amounting to 767,284 tons. The largest amount was taken by Cuba, 345,358 tons, and Canada was second with 135,844 tons. Mexico received 94,122 tons; Italy, 65,649 tons; the French West Indies, 52,240 tons; Ecuador, 22,127 tons; Norway, 6,590 tons; Newfoundland, 11,482 tons; Dutch Guiana, 798 tons; Guatemala, 5,116 tons; British West Indies, 7,525 tons; Spain, 90 tons; France, 5,465 tons; and Malta, 1,764 tons. The total value of the bituminous coal shipped from Philadelphia in 1909 was $2,011,507, as against $2,066,573 in 1908 and $2,433,051 in 1907.

BALTIMORE, MD.

The following review of the coal trade of Baltimore has been prepared for this report by Mr. Maurice J. Lunn, editor of Coal and Coke:

The volume of the coal business of Baltimore in 1909 showed a further decline, following a considerable reduction in the amount of the business in 1908, as compared with the high record figures of 1907. The receipts of coal at Baltimore in 1909 were 5,067,615 long tons, a decrease of 366,231 tons, as compared with 1908; the receipts in 1907 were greater by nearly 900,000 tons than those of 1909. The coastwise coal shipments from the port of Baltimore were 3,579,458 tons, or 377,132 tons below the figures of 1908; they showed a decrease of nearly 500,000 tons, as compared with 1907. There was also a decrease in the exports of coal and coke, there being 332,951 tons of bituminous coal and 50,446 tons of coke exported in 1909, as compared with 347,489 tons of bituminous coal and 105,317 tons of coke in 1908; in 1907 the exports amounted to 559,880 tons of coal and 77,822 tons of coke. The anthracite figures also showed a slight decrease in 1909.

The bituminous-coal trade was not satisfactory during the greater part of the year 1909, but the conditions surrounding the trade were much better than in 1908, when the coal trade, in common with all lines of business, suffered from the general depression following the panic of the latter part of 1907. Although the tonnage in 1909 was less than in 1908, the trade conditions were better and the business more profitable. The anthracite trade was about normal throughout the year, the receipts of hard coal being 746,421 long tons, as against 792,569 tons in 1908 and 803,031 tons in 1907. This branch of the industry at Baltimore is governed to a large extent by weather conditions, practically all anthracite being used for household purposes.

The following tables give the receipts and shipments of coal and coke at Baltimore in 1908 and 1909:

Receipts and shipments of coal at Baltimore, 1908, in long tons.

	Receipts.	Tidewater shipments.	
		Coastwise.	Exports.
Bituminous coal	4,641,277	[a] 3,704,851	347,489
Anthracite	792,569	251,739	1,225
Total	5,433,846	3,956,590	348,714
Coke (short tons)	137,167	....	105,317

[a] Includes part of shipments to Chesapeake Bay points.

Receipts and shipments of coal at Baltimore, 1909, in long tons.

	Receipts.	Tidewater shipments.	
		Coastwise.	Exports.
Bituminous coal	4,321,194	[a] 3,344,225	332,016
Anthracite	746,421	235,233	935
Total	5,067,615	3,579,458	332,951
Coke (short tons)	144,093	....	50,446

[a] Includes part of shipments to Chesapeake Bay points.

The following table gives the coastwise coal shipments from Baltimore for the past seven years:

Coastwise coal shipments from Baltimore, 1903–1909, in long tons.

Year.	Anthracite.	Bituminous.	Total.
1903	....	....	1,731,896
1904	238,728	2,064,060	2,302.788
1905	252,568	2,832,321	3,084,889
1906	238,162	3,176,710	3,414,872
1907	266,062	3,804,066	4,070.128
1908	251.739	3,704,851	3,956,590
1909	235,233	3,344,225	579,458

The exports of bituminous coal and coke from Baltimore, by months, for the year 1909, and the totals for the six preceding years, are shown in the following table, from which it will be observed that the aggregate has fallen back during the last two years to the figures of the year 1905:

Exports of bituminous coal and coke from Baltimore, in 1909, in long tons.

Month.	Bituminous coal.	Coke.
January	15,281	7,011
February	23,234	17,732
March	18,732	3,770
April	35,619	326
May	5,856	3,607
June	42,124	25
July	40,640	6,063
August	43,930	4,424
September	21,013	72
October	45,387	3,174
November	19,374	25
December	20,826	4,217
Total, 1909	332,016	50,446
1908	347,489	105,317
1907	559,880	77,822
1906	458,203	69,230
1905	341,107	32,954
1904	150,912	....
1903	116,294	....

As stated in previous reports, in the opinion of the writer any compilation of the coal tonnage of the port of Baltimore should include the receipts of coal at the plants of the Maryland Steel Company, at

Sparrows Point, about 8 or 9 miles from the city, and that of the Central Foundry Company, located at Dundalk, about 6 miles out of the city. The figures for these two plants are not included in the tables given herewith, but are as follows:

Maryland Steel Company.—The consumption of bituminous coal at this plant during the year 1909 amounted to 517,280 long tons, as compared with 414,279 tons in 1908 and with 517,139 tons in 1907, the figures for 1909 and 1907 being practically the same. These works also consumed 54,226 long tons of coke purchased from outside sources, in addition to the coke manufactured at its own plant, as compared with 10,064 tons of coke from outside sources in 1908 and with 182,928 tons in 1907.

Central Foundry Company.—This plant consumed 4,285 tons of coal and 4,345 tons of coke during the year 1909, as compared with 1,754 tons of coal and 2,298 tons of coke in 1908 and with 2,755 tons of coal and 3,360 tons of coke in 1907.

NORFOLK AND NEWPORT NEWS, VA.

The coal mined in the southern part of West Virginia and in Tazewell and Wise counties in southwestern Virginia, the well-known New River and Pocahontas coals, reach tidewater at Hampton Roads over the Chesapeake and Ohio, the Norfolk and Western, and the Virginian railways. The last-mentioned road was opened for traffic in April, 1909, and during the nine remaining months of the year handled 241,644 long tons of coal which were dumped over the company's pier at Sewall Point, near Norfolk. The Norfolk and Western Railway transports Pocahontas coal to Lamberts Point piers, near Norfolk, and New River coal is sent over the Chesapeake and Ohio Railway to Newport News. The Virginian Railway penetrates both the Pocahontas and the New River coal fields and will in the future be an important carrier for both fields.

According to F. E. Saward's annual report, "The Coal Trade," the total shipments to tidewater at Hampton Roads in 1909 amounted to 7,680,127 long tons against 5,970,081 long tons in 1908, an increase of 1,710,046 long tons. These figures do not include the shipments over the Virginian Railway. Adding these, the increase of total business in 1909 was approximately 2,000,000 long tons, or about 33⅓ per cent.

The reports of the Department of Commerce and Labor, quoted by the same authority, show that the coastwise trade in 1909 amounted to 5,633,286 long tons, and the exports to 1,592,678 long tons, against 4,393,387 and 1,281,920 long tons, respectively, in 1908. The shipments to Newport News and the coastwise trade therefrom are considerably larger than the business done at Lamberts Point, but the export trade is in favor of Pocahontas coal. Bunker trade from the two ports amounts to between 600,000 and 800,000 long tons annually.

The following table shows the business done at Norfolk and Newport News (exclusive of that over the Virginian piers at Sewall Point in 1909) during the last four years. The figures for Norfolk and Lambert's Point have been furnished by Mr. Jos. W. Coxe, comptroller of the Norfolk and Western Railway, and are for the fiscal years ending June 30:

Receipts and shipments of coal at Lamberts Point and Norfolk, Va., 1906–1909, in long tons.

Fiscal years ending June 30—	Export.	Coastwise.	Bunker.	Total.
1906	470,639	2,148,210	333,672	2,952,521
1907	502,601	1,509,787	405,096	2,417,484
1908	675,238	1,564,824	454,373	2,694,435
1909	728,396	1,806,222	469,070	3,003,688

Receipts and shipments of coal at Newport News, Va., 1906–1909, in long tons.

Calendar year.	Receipts.	Coastwise trade.	Exports.	Bunker trade.
1906	3,133,517	2,791,404	180,545	....
1907	3,471,254	2,396,406	692,682	326,590
1908	3,568,858	2,742,294	705,011	300,972
1909	4,451,273	3,344,225	739,937	363,988

PITTSBURG, PA.

In the following tables is presented a statement showing the quantity of coal received in Pittsburg and vicinity, by both rail and water, and the shipments of coal through and from the Pittsburg district to the West during the last five years. This statement has been compiled from reports made to the Geological Survey by officials of the railroads entering Pittsburg and by the United States Army officer in charge of the slack-water navigation on Monongahela River and of the improvements at Davis Island Dam, in Ohio River below Pittsburg. The railroad officials to whom special acknowledgment is due for the information contained in the tables are Messrs. R. H. Large, coal freight agent of the Pennsylvania Railroad at Philadelphia; James P. Orr, assistant freight traffic manager of the Pennsylvania Lines West of Pittsburg, at Pittsburg; W. L. Cromlish, coal and coke agent of the Baltimore and Ohio Railroad, at Pittsburg; J. B. Nessle, general freight agent of the Pittsburg and Lake Erie Railroad, at Pittsburg; J. B. Safford, superintendent of the Pittsburg, Chartiers and Youghiogheny Railway, at Pittsburg; S. P. Woodside, general freight agent of the Wabash Pittsburg Terminal Railway, at Pittsburg. The statistics of the movement of coal through the Monongahela River locks and at the Davis Island Dam have been furnished by Lieut. Col. H. C. Newcomer, Engineer Corps, U. S. Army.

In the total movement of coal to Pittsburg and points west thereof there was an increase in 1909 over 1908 of 5,193,191 short tons, but the record in 1909 was still short by 570,915 short tons of the tonnage moved in 1907, and nearly 1,500,000 tons less than the year of maximum activity, 1906. The increased movement in 1909 was principally in the shipments by water to Pittsburg and vicinity, though there were increases also in the rail movement to the Pittsburg district and in both rail and water shipments to points west of Pittsburg. The shipments by the slack-water navigation on Monongahela River to Pittsburg and vicinity increased from 6,435,851 short tons in 1908 to 9,737,505 tons in 1909, a gain of a little over 50 per cent. This large increase was partly due to the fact that river navigation in 1908 was seriously affected by the prolonged drought of that year. The rail shipments to the Pittsburg district increased from 3,494,905 short tons in 1908 to 4,654,249 tons in 1909. The total shipments to the Pittsburg district in 1909 amounted to 14,391,754 short tons, as compared with 9,930,756 tons in 1908.

To points west of Pittsburg the total shipments in 1909 amounted to 21,445,380 short tons, against 20,713,187 tons in 1908. The shipments by rail were nearly the same in both years, being 18,970,848 tons in 1908 and 18,981,995 tons in 1909. The quantity of coal passing Davis Island Dam increased from 1,742,339 short tons in 1908 to 2,463,385 tons in 1909. The total movement by rail to Pittsburg district and to points west increased from 22,465,753 short tons in 1908 to 23,636,244 tons in 1909, and the total water shipments from 8,178,190 tons to 12,200,890 tons.

These figures do not include any coal mined in the Pittsburg district and shipped to eastern points, nor do they include the shipments of coke. The quantity of Pittsburg coal shipped to eastern points amounted in 1909 to 11,300,162 short tons against 11,666,160 tons in 1908. All of this is shipped by rail. The coke shipments in 1909 amounted to 12,331,481 short tons, of which 10,045,040 short tons were shipped to Pittsburg and points west, and 2,286,441 tons were shipped to eastern points. The eastern shipments of coke do not, of course, include any from the Connellsville district.

The rail and water shipments to and from the Pittsburg district during the last five years have been as shown in the following table:

Movement of coal to and through Pittsburg, 1905–1909, in short tons, showing totals by rail and water.

	1905	1906	1907	1908	1909
By rail:					
To Pittsburg district	5,463,012	5,107,413	4,774,977	3,494,905	4,654,249
To west of Pittsburg	18,370,368	22,419,496	20,817,263	18,970,848	18,981,995
Total by rail	23,833,380	27,526,909	25,592,240	22,465,753	23,636,244
By Monongahela River locks:					
To Pittsburg district	5,558,541	6,840,816	7,611,680	6,435,851	9,737,505
To west of Pittsburg	3,926,319	2,883,965	3,204.129	1,742,339	2,463,385
Total by water	9,484,860	9,724,781	10,815,809	8,178,190	12,200,890
Total shipments	33,318,240	37,251,690	36,408,049	30,643,943	35,837,134

Movement of coal to and through Pittsburg, 1905–1909, in short tons, showing totals to Pittsburg district and west of Pittsburg.

	1905	1906	1907	1908	1909
To Pittsburg district:					
By rail	5,463,012	5,107,413	4,774,977	3,494,905	4,654,249
By water	5,558,541	6,840,816	7,611,680	6,435,851	9,737,505
Total to Pittsburg district	11,021,553	11,948,229	12,386,657	9,930,756	14,391,754
To west of Pittsburg:					
By rail	18,370,368	22,419,496	20,817,263	18,970,848	18,981,995
By water	3,926,319	2,883,965	3,204,129	1,742,339	2,463,385
Total to west of Pittsburg	22,296,687	25,303,461	24,021,392	20,713,187	21,445,380
Total shipments to Pittsburg and points west	33,318,240	37,251,690	36,408,049	30,643,943	35,837,134
Shipments, all rail, to points east of Pittsburg			12,202,530	11,666,160	11,300,162

BUFFALO, N. Y.

The following review of the Buffalo coal market is taken from the annual volume "The Coal Trade," published by F. E. Saward, of New York:

The movement of hard coal by water from Buffalo during the year 1909 fell off about 500,000 tons from that of 1908. The coal was available and the shippers believed that it would all be needed by consumers west of Lake Michigan, but all effort to induce them to buy early failed, so that by early fall the receiving docks were choked up and shipments could no longer be made as anticipated. The railroads were therefore called upon during the winter to make up the deficiency from the anthracite mines direct.

The Lake season was not very active till midsummer, as the effect of the business depression of 1907 had not disappeared, but the fall trade was good. Ore shippers took advantage of the brisk buying and moved a vast amount of iron ore by Lake after September 1, but the hard-coal consumers could not be induced to buy until too late to fill up the coal docks again for a full winter supply.

The movement of soft coal to Buffalo from West Virginia, which was a novelty in 1908, continued in 1909, being accomplished by discounting a prohibitive all-rail rate and taking advantage of a low Lake rate from Sandusky. The amount received during the season of 1909 was 57,781 tons, which is about the amount of the season of 1908. Though this coal all went practically to one consumer it has added to the uneasiness in the soft-coal trade, especially as the West Virginia operators have shown an increased aggressiveness of late in the eastern market.

In the handling of bituminous coal Buffalo profited by an increase of factories at home, by interruptions more or less serious on the car-ferry lines across Lake Erie, and by the condition of the Detroit River late in the fall, which diverted considerable bituminous coal to the Buffalo route.

Destination of the anthracite shipped by water from this port in 1909 compares as follows with preceding years, as per customhouse report:

Lake shipments of anthracite from Buffalo, 1905 to 1909, in long tons.

To—	1905	1906	1907	1908	1909
Chicago	1,068,695	939,407	1,294,166	1,392,071	1,245,001
Milwaukee	474,936	511,424	484,453	631,800	389,150
Duluth	339,168	268,818	315,600	260,650	192,925
Superior	425,398	499,486	822,720	793,214	725,425
Other ports	355,530	462,673	541,776	460,363	500,205
Total	2,663,727	2,681,808	3,458,715	3,538,098	3,052,706

In the past three years there has been practically no change in the receipts of coal by rail.

The following is a comparative statement of shipments to Canadian points, by rail and water, as reported by the collector of customs, in long tons:

Shipments of coal and coke from Buffalo to Canadian points, 1905 to 1909, in long tons.

Year.	Bituminous.	Anthracite.	Coke.	Total.
1905	532,555	1,739,274	140,107	2,411,936
1906	593,787	1,750,403	150,000	2,494,199
1907	809,192	2,036,914	204,821	3,050,947
1908	786,063	1,726,332	213,712	2,726,107
1909	800,741	1,748,759	350,085	2,899,585

The water shipments from Buffalo in late years have been almost entirely anthracite, as the freight rates from the mines as compared with other Lake Erie ports practically cut off the soft coal, the single item of 10,400 tons to Port Colborne at the mouth of the Welland Canal, which is only 18 miles from Buffalo, being practically all the soft coal shipped by water. This coal was all carried in a single barge, in its several trips.

The following were the quotations per short ton of soft coal at the International Bridge, Buffalo:

Prices of bituminous coal at Buffalo in 1909, per short ton.

	Three-quarter lump.	Mine-run.	Slack.
Pittsburg region	$2.50	$2.40	$2.15
Reynoldsville and Shawmut	2.40	2.30	2.10
Allegheny Valley	2.30	2.20	2.05

Closing quotations of anthracite were as follows, on cars at Buffalo or bridges, per long ton: Broken (grate), $5.25; stove, $5.50; egg, $5.50; chestnut, $5.50.

CINCINNATI, OHIO.

The following review of the coal trade of Cincinnati is from the annual report of Mr. Charles B. Murray, superintendent of the Cincinnati Chamber of Commerce:

The arrivals of coal in the Cincinnati market in 1909 were 12½ per cent in excess of those of 1908, but were short of the receipts for 1907, 1906, and 1905. The records for the year 1909 indicate gains in receipts by both river and rail. In the local trade there was little of an unusual nature, and the supply was ample for requirements throughout the year. River stages admitted of transportation of coal during most of the year, the interruptions occurring in the late months from low stages of water. The aggregate receipts of coal at Cincinnati in 1909 were 135,627,000 bushels, or 4,896,000 tons, as compared with 120,637,000 bushels for 1908, and with an annual average of 144,515,000 bushels for five years prior to 1909. The year's aggregate shipments were 69,938,000 bushels, as compared with 64,234,000 bushels for 1908, and an annual average of 68,669,000 bushels for five years prior to 1909.

The receipts of coal in 1909 by river were 46,056,000 bushels, as compared with 35,765,000 bushels for 1908, and with an annual average of 54,781,000 bushels for five years prior to 1909. Of these receipts for the year 1909 about 45 per cent represented product from the Pittsburg district as against 38 per cent of like product in 1908.

Receipts of coal by railroad in 1909 were 89,571,000 bushels, as compared with 84,872,000 bushels for 1908, and an annual average of 89,935,000 bushels for five years prior to 1909. It is estimated that about 55 per cent of the receipts by railroad represented product from the Kanawha district, and 45 per cent from other sources, mainly Ohio. Shipments of coal by river are usually not large; they showed 6,727,000 bushels in 1909, as compared with 3,380,000 bushels in 1908, and with an annual average of 4,820,000 bushels for five years prior to 1909.

Shipments of coal by railroad, as reported, include a quantity that can not be stated, representing as it does through movement of coal, though appearing on the way bills of local offices. The total for 1909 was 63,211,000 bushels, against 60,854,000 for 1908, and an annual average of 63,849,000 for five years prior to 1909.

For coal afloat, from both Pittsburg and Kanawha districts, the quotation was 8½ cents per bushel the first two months of the year and 8 cents subsequently, on the basis of which the year's average price would be about 8.10 cents per bushel. Run-of-mine coal sells at about three-fourths of a cent per bushel below the standard price for lump, and nut and slack at a difference of about 2 cents. For lump coal delivered to consumers the price for both Pittsburg and Kanawha was $3.50 per ton the first two months, $3.25 the third month, and $3 subsequently, until the last half of December, when $3.25 was the figure.

The general average for 1909 was $3.15 per ton, or about 11.35 cents per bushel, as compared with 12.25 cents for 1908, and with an annual average of 12.30 cents for five years prior to 1909. For nut and slack coal, the range was mainly from $1.90 to $2.10 per ton for deliveries to consumers.

Anthracite coal is but moderately consumed in this market, the total receipts in 1909 being 471,000 bushels, compared with 855,000 bushels in 1908, and an annual average of 719,000 bushels for five years prior to 1909. The price for lots delivered to consumers was $7.50 per ton throughout the year.

The local consumption of coal, as near as can be estimated upon statements of dealers, has been pretty evenly divided between industrial and household requirements, with a tendency of enlargement of the industrial proportion in late years, so that probably 55 per cent is not too high to estimate such consumption at this time.

The local gas works having arranged for a supply of natural gas, the manufactured product was produced only during a part of the year, the consumption of coal for such purpose being about 100,000 tons of 2,000 pounds. There was sent out by the gas works during the year, 995,511,000 cubic feet of manufactured gas, 2,866,250,000 feet of natural gas, and product of electric current representing 45,483,000 kilowatts. The total of manufactured and natural gas sent out by the gas works in 1909 was 3,861,000,000 cubic feet, against 3,020,000,000 cubic feet in 1908, an increase of nearly 28 per cent. The increase in electric current was slightly over 4 per cent.

The yearly range and average prices of Pittsburg coal, afloat and delivered, per bushel, based on weekly records, compare for a series of years as shown in the following compilation:

Prices of Pittsburg coal at Cincinnati, 1898–1909, in cents per bushel.

Year.	Afloat.			Delivered.		
	Lowest.	Highest.	Average.	Lowest.	Highest.	Average.
1898	5	6	5.66	7¼	9	8.10
1899	4½	7½	5.30	8⅛	11¾	8.05
1900	7½	8	7.50	10¾	11¾	9.50
1901	6½	8	7.50	9	10¾	10.90
1902	6½	10	7.92	10	14½	10.55
1903	9	10	9.25	12⅝	14½	11.75
1904	8	9	8.50	10¾	13½	13.18
1905	8	8	8.00	11¾	12⅝	11.50
1906	7½	8½	7.80	11¾	12⅝	12.20
1907	8	9	8.20	11¾	14⅜	12.45
1908	8½	8½	8.50	11¾	13½	12.25
1909	8	8½	8.10	10¾	12⅝	11.35

Coal from the Kanawha, Virginia, and West Virginia regions sells at the same, or about the same prices, as are obtained for the product from the Pittsburg district. Sales afloat are on the bushel basis, 72 pounds; sales delivered are on the ton basis, 2,000 pounds, and represent screened or lump grade.

The receipts of coke for the year were 3,260,000 bushels, and the quantity locally manufactured was 4,397,000 bushels, making a total of 7,657,000 bushels, compared with 9,668,000 bushels the preceding year. For city manufacture the average price for the year was 11½ cents per bushel; of gas house, 10¼ cents; of Connellsville, $5.20 per ton.

Summary of coal movements at Cincinnati, Ohio, in 1908 and 1909, in bushels.

Details.	1908.	1909.	Details.	1908.	1909.
Total received	120,637,000	135,627,000	Anthracite	855,000	471,000
Pittsburg	13,397,000	20,765,000	Total:		
Ohio River	679,000	39,000	By river	35,765,000	46,056,000
Kanawha:			By rail	84,872,000	89,571,000
By river	21,689,000	25,252,000	Shipped:		
By rail	46,209,000	49,005,000	By river	3,380,000	6,727,000
Total Kanawha	67,898,000	74,257,000	By rail	60,854,000	63,211,000
Other kinds by rail	37,808,000	40,095,000	Total shipped	64,234,000	69,938,000

CLEVELAND, OHIO.

The total coal and coke receipts at Cleveland in 1909, as reported by Mr. Munson A. Havens, secretary of the Cleveland Chamber of Commerce, amounted to 7,662,809 short tons, which quantity was both an increase of 670,569 short tons in 1909 over 1908 and established the record for the coal trade of the city. In no previous year have the receipts exceeded 7,000,000 tons, the nearest approach to that figure being in 1907, when the quantity of coal and coke received at the lake port amounted to 6,998,124 short tons. The increase in receipts in 1909 was almost equally divided between coal and coke, with a slight advantage in favor of the latter. Coke receipts increased 343,907 short tons and coal receipts 326,662 short tons. The increase in coal receipts was entirely in bituminous. Anthracite receipts decreased from 515,717 short tons in 1908 to 363,162 short tons in 1909, whereas bituminous coal arriving at Cleveland increased from 5,715,781 short tons to 6,264,998 tons. It is worthy of note that all of this increase in receipts, and more, was for local consumption, for while the receipts increased 670,569 short tons the shipments decreased somewhat more than that figure and the local consumption increased from 3,371,881 tons in 1908 to 4,809,962 tons in 1909.

The following tables show the quantities of anthracite and of bituminous coal and coke received at and shipped from Cleveland during the last five years:

Coal and coke receipts and shipments at Cleveland, Ohio, 1905–1909, in short tons.

RECEIPTS.

Kind.	1905.	1906.	1907.	1908.	1909.
Bituminous	4,846,162	6,021,958	5,995,197	5,715,781	6,264,998
Anthracite	295,423	145,822	153,077	515,717	363,162
Coke	583,053	659,307	849,850	690,742	1,034,649
	5,724,638	6,827,087	6,998,124	6,922,240	7,662,809

SHIPMENTS.

Kind.	1905.	1906.	1907.	1908.	1909.
Anthracite by rail	74	10,138	7,553	41,428	25,383
Bituminous by rail	50,575	45,687	112,500	82,542	122,814
Bituminous by lake	2,567,916	2,926,279	3,264,875	3,350,830	2,602,275
Coke by rail	45,527	117,718	56,738	75,559	102,375
	2,664,092	3,099,822	3,441,666	3,550,359	2,852,847

Total coal receipts and shipments, with local consumption, at Cleveland, Ohio, 1905–1909, in short tons.

Year.	Receipts.	Shipments.	Local consumption.
1905	5,724,638	2,664,092	3,060,546
1906	6,827,087	3,099,822	3,727,265
1907	6,998,124	3,441,666	3,556,458
1908	6,922,240	3,550,359	3,371,881
1909	7,662,809	2,852,847	4,809,962

CHICAGO, ILL.

The following review of the Chicago Coal Market is taken from the annual volume, "The Coal Trade," published by F. E. Saward, of New York:

Readjustment defines, more accurately than any other word perhaps, the superficial changes that took place in the Chicago coal trade during the year 1909. The largest industrial buyer in this market is the United States Steel Corporation. During the year it severed commercial relations with the company that for many years had been supplying it with fuel, broke up its fuel requirements for the year into fragments and scattered them among various western coal shippers, and then later in the year purchased and took possession of lands and mines in the Danville district, which this year it will operate to supply its heavy fuel requirements for South Chicago and Gary.

Commercially the earlier months of 1909 were bad for the western coal producing companies. Prices at which annual contracts were accepted in the summer of 1908 were lower than they had been in many years. As the summer advanced the expansion of industrial activities was felt to a greater extent by the coal operators. There was a steady though slow improvement in the situation, and, when during the later months of the year the car shortage became pronounced, there was a period of excellence such as the trade had not experienced for years. The comparatively brief activity and strength did not perhaps fully atone for the long period of depression and financial ills that preceded it, but it served to relieve what would otherwise have been a year of extreme and unprofitable monotony. Although the weather proved an aid in this later activity and although the lagging dealer trade also contributed its part to the satisfactory close, the back log to the strength consisted of the industrial expansion, which called for a greatly increased tonnage of fuel. It was in the late autumn and early winter months that plants which had been running on part time began to run steadily and plants which had been running steadily began to operate night shifts. They consequently increased their fuel specifications to such an extent that many of the producing companies found their entire (though increased) output absorbed by the requirements of their cheap annual contracts.

And about this time also the channels of transportation in and about Chicago became seriously congested and interfered sadly with the delivery of coal. The reason therefor has no special application to Chicago, for it was as wide as the country. During the two years prior to 1909 the western roads had neglected making improvements beyond those that were imperative, and when heavier transportation demands were made upon them they were physically unable to respond. The steady growth of traffic and the standstill condition of railroad facilities together constitute one of the most serious industrial problems which the future has in store, particularly at points like Chicago, where traffic is densely massed. There seems to be a splendid opportunity for the frequent recurrence of the trouble.

It was the expansion of the industrial fuels and not the household requirements that gave the markets their zest. The latter have had the normal increase of the year but nothing spectacular. The retail trade at Chicago locally witnessed some further progress toward concentration during the year, the largest retailing company, formed late in 1908, making some further acquisitions in yards. What effect this may have upon producing interests is not made clear, for owing to the strenuous demand for coal at Chicago the relations between buyer and seller overspread ordinary channels during the latter part of the year. Throughout the summer there was a period of sharp warfare in the Chicago retail market during which prices fell to an unremunerative basis, but upon restoration of prices there was a steadier condition of the market than had prevailed for some time.

The year 1909 also marked the further advance of the southern Illinois field as the principal center of production in the bituminous districts supplying this market, not so much by the opening of new mines, for development work of that sort was very slight, but by the increased capacity of mines previously in operation. There is an absence of statistics of the relative receipts of bituminous coal at Chicago from the various contributing States, but if a guess were hazarded it might be said that Illinois probably made some moderate gains relatively, though previous tonnages from western Pennsylvania, West Virginia, Ohio, and Indiana may have been maintained, for the total coal traffic of Chicago in 1909 considerably exceeded that of 1908.

There is to be noted, however, a serious shrinkage in the Lake traffic of coal. The receipts of bituminous coal at Chicago fell from 518,818 tons in 1908 to 449,527 tons in 1909, the receipts in 1907 having been 414,534 tons. This bituminous coal went almost entirely to the by-product coking plant at South Chicago. The shrinkage in 1909 did not mean a loss of activity at the coke-making plant but increased receipts of coal by rail. There was an increased experimentation with western coals for coke making during the year, particularly with the coals of Franklin County, Ill., where considerable tracts were bought by eastern capitalists on account of their supposed superior coke-making qualities. The industry, however, has not yet become extensive, nor even well established.

Anthracite receipts at Chicago by Lake were 790,759 tons in 1909, compared with 1,011,170 tons in 1908 and with 1,093,058 tons in 1907. This serious loss is believed to mean two things; first, that the buyers during the season of navigation were unusually slothful, and second, that the tendency of the western anthracite trade is toward all-rail shipments from mines at the expense of Lake business. Concerning the dilatoriness of the dealer trade during the summer and autumn months there is ample evidence. The active buying did not begin until October, and although after it had begun there remained from four to six weeks of navigation within which to get forward Lake coal, yet the demand from all markets increased so at that time that sufficient coal could not fairly be appropriated to the Chicago market to fill up the docks as fast as they were depleted. The impression exists among prominent anthracite shippers at Chicago that the volume of the anthracite trade in this market is being fully maintained and that therefore the receipts of all-rail coal are increasing at a rate at least equal to the diminishing volume of Lake transportation.

Prices for coal in the Chicago market in 1909, per short ton.

Quality.	January.	April.	July.	October.	December.
Anthracite egg, stove, and nut, f. o. b. cars	$6.50	$6.00	$6.30	$6.50	$6.50
Anthracite grate, f. o. b. cars (yard prices 25 cents higher)	6.25	5.75	6.05	6.25	6.25
Pocahontas, New River, and Ocean (Georges Creek):					
Mine-run	$2.90 to 3.15	$3.05 to 3.15	$2.85 to 3.05	$3.05 to 3.20	$2.95 to 3.15
Lump	3.55 to 3.80	3.40 to 3.55	3.15 to 3.40	3.50 to 3.65	3.35 to 3.65
Fairmont, W. Va., three-quarters	2.75 to 3.10	2.80 to 3.00	2.80 to 2.90	2.90 to 3.00	3.00 to 3.10
Kanawha splint, lump	3.00 to 3.25	3.00 to 3.15	3.00 to 3.15	3.20 to 3.25	3.20 to 3.30
Youghiogheny three-quarter-inch lump	3.05 to 3.15	3.00 to 3.15	3.05 to 3.15	3.00 to 3.15	3.00 to 3.15
Hocking, lump	2.90 to 3.15	2.85 to 3.15	2.85 to 3.00	3.05 to 3.15	2.90 to 3.15
Greene and Sullivan County, Ind., 4-inch lump	2.00 to 2.20	2.00 to 2.10	1.80 to 2.10	2.25 to 2.30	2.40 to 2.50
Greene and Sullivan County, Ind., mine-run	1.70 to 1.90	1.70 to 1.90	1.65 to 1.75	1.70 to 1.80	1.70 to 1.80
Cartersville, Ill., 6-inch lump	2.30 to 2.50	2.10 to 2.25	1.90 to 2.15	2.50 to 2.60	2.50 to 2.75
Cartersville, Ill., nut	2.30 to 2.50	2.10 to 2.25	1.90 to 2.15	2.35 to 2.50	2.40 to 2.75
Springfield, Ill., lump	2.00 to 2.25	1.90 to 2.00	1.75 to 1.90	2.15 to 2.25	2.15 to 2.25
Springfield, Ill., mine-run	1.60 to 1.70	1.50 to 1.70	1.60 to 1.75	1.65 to 1.75	1.65 to 1.75
Springfield, Ill., screenings	1.20 to 1.40	1.35 to 1.50	1.40 to 1.50	.95 to 1.05	1.00 to 1.15
Harrisburg, Ill., lump	2.25 to 2.50	2.15 to 2.35	2.10 to 2.25	2.50 to 2.60	2.70 to 2.80
Harrisburg, Ill., mine-run	2.00 to 2.25	1.90 to 2.15	1.80 to 2.15	2.00 to 2.15	2.10 to 2.15
Franklin County, Ill., lump	2.50 to 2.75	2.35 to 2.50	2.15 to 2.35	2.75 to 2.85	2.90 to 3.00
Franklin County, Ill., nut	2.50 to 2.75	2.35 to 2.50	2.15 to 2.35	2.65 to 2.75	2.90 to 3.00
Wilmington, Ill., lump	2.50	2.50	2.50	2.75	2.75
Coke, Connellsville, 72-hour	4.75 to 5.00	4.50 to 4.65	4.65 to 4.90	5.10 to 5.25	5.15 to 5.35
By-product coke	4.75 to 5.00	4.75 to 5.15	4.75 to 5.15	5.10 to 5.25	5.15 to 5.25
Wise County, Va., 72-hour	4.60 to 4.85	....	....	....	....

ST. LOUIS, MO.

The Business Men's League of St. Louis has furnished the following statement of the coal and coke receipts of that city and the prices prevailing during 1909:

Increases were shown in the consumption of anthracite and bituminous coal and of coke in 1909 over 1908. The increase in the receipts of bituminous coal amounted to 289,217 tons, indicating a greater manufacturing activity. Prices for steam coal delivered to St. Louis consumers were lower in 1909 than in 1908, owing to a reduction in freight rates on that grade of coal. Anthracite coal for domestic purposes sold cheaper than at any time in the five preceding years. This probably accounts for an increase of 6,000 tons in its consumption. The consumption of fuel gas showed an increase of 165,435,000 cubic feet, or 7.2 per cent.

St. Louis obtains by far the larger part of its fuel supply from mines in Illinois within a short distance of the city. With the possible exception of Pittsburg, Pa., there is no other large city so favorably situated for securing cheap coal, and it is to this supply of cheap fuel that St. Louis owes its prominence as a manufacturing city.

The receipts of coal and coke at St. Louis for the last five years and high, low, and closing prices in 1908 and 1909 are shown in the following tables:

Coal and coke receipts at St. Louis, Mo., 1905–1909, in short tons.

Year.	Bituminous.	Anthracite.	Coke.	Year.	Bituminous.	Anthracite.	Coke.
1905	6,869,107	158,843	494,011	1908	7,129,055	236,036	357,016
1906	7,621,613	174,226	729,778	1909	7,418,268	236,040	171,570
1907	8,477,476	265,571	826,400				

Coal prices at St. Louis, Mo., during 1908 and 1909, per short ton.

Kind.	1908.			1909.		
	Highest.	Lowest.	Closing.	Highest.	Lowest.	Closing.
Standard Illinois lump coal	$1.80	$1.47	$1.52	$1.92	$1.27	$1.92
High-grade Illinois lump coal	2.62	2.02	2.32	2.37	1.67	2.37
Anthracite, large	6.70	6.20	6.70	6.70	6.20	6.70
Anthracite, small	6.95	6.45	6.95	6.95	6.45	6.95
Connellsville coke	5.25	5.00	5.25	6.05	5.05	6.05
New River coke	5.40	5.25	5.40	5.55	4.55	5.55
Kentucky coke	3 60	3.50	3.60	3.65	3.40	3.65
Gas coke	4.75	4.00	4.25	4.75	4.25	4.75

MILWAUKEE, WIS.

Mr. H. A. Plumb, secretary of the Milwaukee Chamber of Commerce, has furnished for this report the following review of the coal trade of Milwaukee for 1909:

With one exception, the receipts of coal at Milwaukee in the calendar year 1909 were the largest ever recorded—4,176,022 short tons by both Lake and rail. The exception referred to was the year 1907, which has been credited with receipts of 4,349,507 tons. By water transportation alone from lower Lake shipping points 3,822,074 tons were brought to this port; the Lake receipts in 1907 amounted to 4,039,512 tons.

Two lines of car-ferry steamers operate throughout the entire year between Milwaukee and the east shore of Lake Michigan in connection with the Pere Marquette and the Grand Trunk railways, respectively, and by this mode of transportation approximately 6,850 cars, carrying 205,669 tons of coal, mostly bituminous, were shipped into Milwaukee in 1909. The receipts by rail, chiefly from Indiana and Illinois, were 148,279 tons.

Milwaukee's importance as a coal receiving and distributing point is well established, and is due primarily to her excellent harbor, vessels laden with 12,000 tons of coal unloading without difficulty at her docks. In the year 1908 more than 50 cargoes of over 10,000 tons each were among the arrivals at this port, and in 1909 78 coal-laden vessels bearing over 10,000 tons each entered the port of Milwaukee. The largest cargo ever received at Milwaukee—12,885 tons—was that of the steamer *L. S. De Graff*, in August, 1909; the average size of cargoes received in 1909 was 6,152 tons. These large carriers enter the rivers of Milwaukee and unload their cargoes without delay. Seven miles of navigable river constitute her inner harbor, along whose length are scattered coal docks equipped with the latest devices for the rapid unloading of vessels. Her swing bridges, which have in some instances been somewhat of an obstruction to navigation, are being replaced with modern structures of the bascule type, with the result that the largest vessels are able to pass without difficulty spots where groundings formerly occurred.

Thus favored, Milwaukee remains in the front rank as a coal-receiving port, as may be seen by the following statement compiled from reports of the Department of Commerce and Labor. These figures, which show the total receipts by Lake, include at Milwaukee the receipts by car ferries.

Coal received by Lake, in short tons.

	1908.	1909.
Superior	4,207,823	4,052,735
Milwaukee	3,810,596	4,040,436
Duluth	1,705,869	1,590,106
Chicago and South Chicago	1,577,179	1,282,281

From this table it is seen that of the four principal coal-receiving ports of the Great Lakes, Milwaukee alone showed an increase in the quantity received in 1909 as compared with 1908, decreases being recorded at the other three ports. The figures include coal used as fuel by the carriers.

The shipments of coal—that is, the amount distributed to interior points from Milwaukee by rail—were the largest ever recorded, 1,382,660 short tons. In this connection it may be said that transportation facilities were badly disorganized during the winter of 1909 owing to severe weather conditions, and although the carriers gave coal shipments the preference over other classes of freight, dealers suffered greatly from difficulty in obtaining cars.

Fair-sized stocks of coal remained on hand at the close of the winter. The storage capacity of Milwaukee coal docks is approximately, anthracite, 600,000 short tons; bituminous, 1,800,000 tons; a total of 2,400,000 tons.

The price of anthracite coal did not differ materially in 1909 from the price in 1908, but bituminous coal ranged about 25 cents per ton lower, owing to the immense receipts—not less than 3,340,000 tons of the total receipts of the year being bituminous coal.

Freight rates on coal from Ohio ports to Milwaukee during the 1909 season of navigation averaged 41 cents per ton on anthracite and 37 cents on bituminous. From Buffalo the rates to Milwaukee ruled about 35 cents the entire season up to December, when carriers were paid all the way from 75 cents to $1 per ton.

The receipts at and shipments from Milwaukee during the last five years, and the total receipts for a series of years since 1865, are shown in the following tables:

Receipts of coal at Milwaukee, Wis., 1905–1909, in short tons.

Source.	1905.	1906.	1907.	1908.	1909.
By Lake from—					
Buffalo	800,814	748,644	813,904	1,005,594	778,392
Erie	60,641	66,964	140,313	17,359	80,980
Oswego	4,369	8,002	28,428	58,285	56,588
Cleveland	247,878	560,475	740,785	520,244	382,828
Ashtabula	245,455	263,527	318,046	167,851	212,314
Lorain	159,788	157,515	204,873	337,465	610,444
Sandusky	359,427	362,408	457,582	451,807	393,869
Toledo	770,962	851,521	1,064,666	891,626	1,057,076
Fairport	23,051	25,627	50,041	77,001	108,210
Huron, Ohio	87,008	160,274	134,508	22,425	26,015
Other ports	75,739	149,115	88,366	111,510	115,358
Total, Lake	2,835,132	3,354,072	4,039,512	3,661,167	3,822,074
By railroad	[a] 322,332	[b] 461,203	[c] 309,995	[d] 380,759	[e] 353,948
Receipts	3,157,464	3,815,275	4,349,507	4,041,926	4,176,022

[a] Including 241,606 tons by car-ferry lines.
[b] Including 319,935 tons by car ferry.
[c] Including 132,516 tons by car ferry.
[d] Including 168,205 tons by car ferry.
[e] Including 205,669 tons by car ferry.

Shipments of coal from Milwaukee, Wis., 1905–1909, in short tons.

Shipped by—	1905.	1906.	1907.	1908.	1909.
Chicago, Milwaukee and St. Paul Ry	668,509	631,205	698,040	632,184	776,010
Chicago and Northwestern Ry	512,536	459,333	509,271	471,101	483,250
Wisconsin Central Ry [a]	87,105	93,766	103,551	99,411	123,500
Lake	9,460	4,138	....	....	....
	1,277,610	1,188,442	1,310,862	1,202,696	1,382,760

[a] The Wisconsin Central Railway has now become the "Soo Line."

Total receipts of coal by Lake from lower Lake ports at Milwaukee, Wis., 1905–1909, by kinds, in short tons.

Kind.	1905.	1906.	1907.	1908.	1909.
Anthracite	802,083	756,646	858,402	1,063,879	834,980
Bituminous	2,033,049	2,597,426	3,181,110	2,597,288	2,987,094
	2,835,132	3,354,072	4,039,512	3,661,167	3,822,074

Receipts of coal at Milwaukee, Wis., by Lake and rail in 1865, 1870, 1880, 1890, and annually from 1900 to 1909, in short tons.

1865	36,369	1903	3,023,977
1870	122,865	1904	2,944,439
1880	368,568	1905	3,157,464
1890	999,657	1906	3,815,275
1900	1,808,593	1907	4,349,507
1901	1,953,489	1908	4,041,926
1902	1,641,095	1909	4,176,022

Lake freights on coal from Buffalo to principal upper Lake ports during the season of 1909, as compared with those of 1908, were as follows:

Freight rates per ton on coal from Buffalo to principal upper Lake ports, 1908 and 1909, by months.

Month.	To Milwaukee.		To Chicago.				To Duluth.	
			North Branch.		South Branch.			
	1909.	1908.	1909.	1908.	1909.	1908.	1909.	1908.
March	$0.35	$0.40	$0.40	$0.40	$0.45	$0.50	$0.30	$0.30
April	.35	.40	.40	.40	.45	.50	.30	.30
May	.35	.40	.40	.40	.45	.50	.30	.30
June	.35	.40	.40	.40	.45	.50	.30	.30
July	.35	.40	.40	.40	.45	.50	.30	.30
August	.35	.40	.40	.40	.45	.50	.30	.30
September	.35	.40	.40	.40	.45	.50	.30	.30
October	.35	.40	.40	.40	.45	.50	.30	.30
November	.35	.40	.40	.40	.45	.50	.30	.30
December	.75 to 1.00	.50	.75	.50	.75	.55	.75	.50

SEATTLE, WASH.

The coal trade at Seattle has shown a decided loss in the last two years, the exports having decreased from 564,413 tons in 1907 to 377,533 tons in 1908, and to 353,290 tons in 1909. F. E. Saward, in his annual report, "The Coal Trade," estimates the receipts of coal at Seattle from the mines in Washington at 600,000 tons in both 1908 and 1909, against 950,000 tons in 1907. Receipts at and exports from the port of Seattle during the last five years have been as follows:

Receipts at and exports from Seattle, Wash., 1905–1909, in short tons.

Year.	Receipts.	Exports.
1905	900,000	423,613
1906	927,500	463,719
1907	950,000	564,413
1908	600,000	377,533
1909	600,000	353,290

PRODUCTION OF COAL BY STATES AND TERRITORIES.

GEOGRAPHIC DIVISIONS.

Twenty-nine States reported a production of coal in 1909, a decrease of one from 1908. A small quantity (50 tons) of lignite was mined near Marthas Vineyard, Mass., in 1908, and used as fuel in one of the clay-working establishments in that vicinity; no production was reported from the property in 1909, and Massachusetts again dropped from the list of coal-producing States. During 1909 work on the rehabilitation of the old mines at Portsmouth, R. I., was in progress, but they did not reach the stage of production during that year. It is claimed that a new and patented process for aiding combustion will make the Rhode Island coal available for market. In addition to these, there are three States in which small quantities of coal have been produced in previous years, namely, North Carolina, Nebraska, and South Dakota, but no output has been reported from any of them in the last few years. Of the 29 States and Territories which produced coal in 1909, 12 are east of Mississippi River and 17 west of it. In 1909 the 12 States east of Mississippi River produced 406,084,885 short tons, or 88.1 per cent of the total, the 17 States west of Mississippi River produced 54,718,531 short tons of coal, or 11.9 per cent of the total. In 1908 the States east of the Mississippi produced 367,377,636 short tons, and the States west of the river, 48,465,012 short tons, the percentages being, respectively, 88.3 and 11.7. Of the States east of the Mississippi 6 are north of the boundary line formed by Ohio and Potomac rivers and 6 south of it. The 6 Northern States consist of Pennsylvania, Maryland, Ohio, Illinois, Indiana, and Michigan. In 1909 they produced 318,512,773 short tons, or 69.1 per cent of the total output. The 6 Southern coal-producing States are Virginia, West Virginia, Alabama, Georgia, Tennessee, and Kentucky, which in 1909 produced 87,572,112 short tons, or 19 per cent of the total. The relative growth in production of these two sections in 10 years is shown in the statement that in 1900 the Southern States produced 42,607,053 short tons and the Northern States 193,324,621 short tons, and that, therefore, the production in the Southern States in 1909 was more than double that of 1900, while in the Northern States the increase was 65 per cent.

In the following table is given the production of the various States, grouped according to the geographic divisions made by Mississippi, Ohio, and Potomac rivers, for the years 1880, 1890, 1900, 1908, and 1909, in order that the development of the different sections may be observed:

Coal production in States north of Ohio and Potomac rivers in 1880, 1890, 1900, 1908, and 1909, in short tons.

State.	1880.		1890.		1900.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Illinois	6,115,377	$8,779,832	15,292,420	$14,171,230	25,767,981	$26,927,185
Indiana	1,454,327	2,150,258	3,305,737	3,259,233	6,484,086	6,687,137
Maryland	2,228,917	2,585,537	3,357,813	2,899,572	4,024,688	3,927,381
Michigan	100,800	224,500	74,977	149,195	849,475	1,259,683
Ohio	6,008,595	7,719,667	11,494,506	10,783,171	18,988,150	19,292,246
Pennsylvania:						
Anthracite	28,711,379	42,282,948	46,468,641	66,383,772	57,367,915	85,757,851
Bituminous	18,425,163	18,567,129	42,302,173	35,376,916	79,842,326	77,438,545
Total	63,044,558	82,309,871	122,296,267	133,023,089	193,324,621	221,290,028

State.	1908.		1909.	
	Quantity.	Value.	Quantity.	Value.
Illinois	47,659,690	$49,978,247	50,904,990	$53,522,014
Indiana	12,314,890	13,084,297	14,834,259	15,154,681
Maryland	4,377,093	5,116,753	4,023,241	4,471,731
Michigan	1,835,019	3,322,904	1,784,692	3,199,351
Ohio	26,270,639	27,897,704	27,939,641	27,789,010
Pennsylvania:				
Anthracite	83,268,754	158,178,849	81,059,159	149,415,847
Bituminous	117,179,527	118,816,303	137,966,791	130,085,237
Total	[a] 292,905,612	376,395,057	318,512,773	383,637,871

[a] Exclusive of Massachusetts.

Coal production in States south of Ohio and Potomac rivers in 1880, 1890, 1900, 1908, and 1909, in short tons.

State.	1880.		1890.		1900.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Alabama	323,972	$476,911	4,090,409	$4,202,469	8,394,275	$9,793,785
Georgia	154,644	231,605	228,337	238,315	315,557	370,022
Kentucky	946,288	1,134,960	2,701,496	2,472,119	5,328,964	4,881,577
North Carolina	350	400	10,262	17,864	17,734	23,447
Tennessee	495,131	629,724	2,169,585	2,395,746	3,509,562	4,003,082
Virginia	43,079	99,802	784,011	589,925	2,393,754	2,123,222
West Virginia	1,829,844	2,013,671	7,394,654	6,208,128	22,647,207	18,416,871
Total	3,793,308	4,587,073	17,378,754	16,124,566	42,607,053	39,612,006

State.	1908.		1909.	
	Quantity.	Value.	Quantity.	Value.
Alabama	11,604,593	$14,647,891	13,703,450	$16,306,236
Georgia	264,822	364,279	211,196	298,792
Kentucky	10,246,553	10,317,162	10,697,384	10,079,917
North Carolina	....	....	....	....
Tennessee	6,199,171	7,118,499	6,358,645	6,920,564
Virginia	4,259,042	3,868,524	4,752,217	4,251,056
West Virginia	41,897,843	40,009,054	51,849,220	44,661,716
Total	74,472,024	76,325,409	87,572,112	82,518,281

Coal production in States and Territories west of Mississippi River in 1880, 1890, 1900, 1908, and 1909, in short tons.

State or Territory.	1880.		1890.		1900.	
	Quantity	Value.	Quantity.	Value.	Quantity.	Value.
Arkansas	14,778	$33,535	399,888	$514,595	1,447,945	$1,653,618
California	236,950	663,013	110,711	283,019	172,908	540,031
Colorado	462,747	1,041,350	3,094,003	4,344,196	5,244,364	5,858,036
Idaho	....	....	....	....	10	50
Indian Territory	120,947	274,550	869,229	1,579,188	1,922,298	2,788,124
Iowa	1,461,116	2,507,453	4,021,739	4,995,739	5,202,939	7,155,341
Kansas	771,442	1,517,444	2,259,922	2,947,517	4,467,870	5,454,691
Missouri	844,304	1,464,425	2,735,221	3,382,858	3,540,103	4,280,328
Montana	224	800	517,477	1,252,492	1,661,775	2,713,707
Nebraska	200	750	1,500	4,500	....	....
New Mexico	....	....	375,777	504,390	1,299,299	1,776,170
North Dakota	....	....	30,000	42,000	129,883	158,348
Oregon	43,205	97,810	61,514	177,875	58,864	220,001
Texas	....	....	184,440	465,900	968,373	1,581,914
Utah	14,748	33,645	318,159	552,390	1,147,027	1,447,750
Washington	145,015	389,046	1,263,689	3,426,590	2,474,093	4,700,068
Wyoming	589,595	1,080,451	1,870,366	3,183,669	4,014,602	5,457,953
Total	4,705,271	9,104,272	18,113,635	27,656,918	33,752,353	45,786,130

Coal production in States and Territories west of Mississippi River in 1880, 1890, 1900, 1908, and 1909, in short tons—Continued.

State or Territory.	1908.		1909.	
	Quantity.	Value.	Quantity.	Value.
Arkansas	2,078,357	$3,499,470	2,377,157	$3,523,139
California	*a* 21,862	69,650	*a* 48,636	107,342
Colorado	9,634,973	13,586,988	10,716,936	14,296,012
Idaho	5,429	21,832	4,553	19,459
Iowa	7,161,310	11,706,402	7,757,762	12,793,628
Kansas	6,245,508	9,292,222	6,986,478	10,083,384
Missouri	3,317,315	5,444,907	3,756,530	6,183,626
Montana	1,920,190	3,771,248	2,553,940	5,036,942
Nebraska				
New Mexico	2,467,937	3,368,753	2,801,128	3,619,744
North Dakota	320,742	522,116	422,047	645,142
Oklahoma (Indian Territory)	2,948,116	5,976,504	3,119,377	6,253,367
Oregon	86,259	236,021	87,276	235,085
Texas	1,895,377	3,419,481	1,824,440	3,141,945
Utah	1,846,792	3,119,338	2,266,899	3,751,810
Washington	3,024,943	6,690,412	3,602,263	9,158,999
Wyoming	5,489,902	8,868,157	6,393,109	9,896,848
Total	48,465,012	79,593,501	54,718,531	88,746,472

a Includes Alaska.

INDIVIDUAL STATES AND TERRITORIES.

The production of coal in the several States and Territories in 1909 and preceding years is discussed more in detail in the following pages:

ALABAMA.

Total production in 1909, 13,703,450 short tons; spot value, $16,306,236.

Compared with the output of 1908, the production of coal in Alabama in 1909 showed an increase of 2,098,857 short tons, or 18.1 per cent, in quantity and of $1,658,345, or 11.3 per cent, in value, but was still 547,004 short tons less than the record of 1907, when the production amounted to 14,250,454 short tons. With the exception of 1907, however, the output in 1909 was the largest in the history of the State. The statistics indicate an encouraging improvement from the effects of the business depression of 1907–8, but there was nothing approaching a boom, and conditions were not so favorable to the speculative development of new properties as they have been during former recoveries from periods of depression. During the last three months of the year, when the demand for coal is naturally stimulated by the advent of cold weather, there was some complaint of shortage of labor; and during November the car supply was at times insufficient for the demands, but conditions in this latter respect improved during December.

Since 1904, when most of the larger mines were closed for a considerable period by labor disaffection, coal mining in Alabama has been carried on chiefly on the open-shop basis. A two months' strike among the union miners in the summer of 1908 failed to strengthen organized labor in the State. During 1909 the industry in Alabama was not affected by labor troubles, not a single strike, suspension, or lockout having been reported.

Alabama is singularly fortunate in having a home market for its coal and coke in the blast furnaces and steel works within its own borders. The advantages of such home markets are plainly exhibited by a comparison of the prices obtained for Alabama coal and coke with those for West Virginia's products. The average price for Alabama coal in 1909 was $1.19 per ton, against $1.26 in 1908 and $1.29 in 1907. West Virginia coal, which includes the high-grade product of the Pocahontas and the New River districts, sold for 99 cents per ton in 1907, 95 cents in 1908, and 86 cents in 1909. In other words, the value at the mines of Alabama coal is 30 per cent more than that of West Virginia, and even the most enthusiastic Alabamian would not say that the average quality of Alabama coal is higher than that of West Virginia. Similar differences in favor of Alabama are shown in the prices obtained for coke. Alabama coke brought an average of $3.04 per ton in 1908 and $2.61 per ton in 1909; whereas the prices for West Virginia coke for the two years, respectively, were $2 and $1.88. Of more importance than this, however, is the building up of permanent communities and the elevation of the character of citizenship which result from the development of manufacturing enterprises.

According to the report of Mr. Ed. Flynn, the State mine inspector, there were 129 deaths by accident and 59 injuries in the coal mines of Alabama in 1909, as compared with 108 deaths and 58 injuries in 1908. The death rate per thousand men employed in 1909 was 6.4 and the number of tons mined for each life lost was 106,228; in 1908, there were 107,450 tons mined for each fatality and the death rate per thousand employees was 5.6. Of the total number of men killed, 24 met death in 1909 through explosions of gas or dust, the most serious being what is supposed to have been an explosion of dust in April at the Short Creek mine of the Birmingham Coal and Iron Company, in which 18 men were killed. More than half of the total number of deaths were due to falls of roof or coal, 70 men being killed in this way. Ten were killed by powder explosions and windy shots, and 25 deaths were due to miscellaneous causes. The statistics of fatal accidents in the coal mines of Alabama have been compiled since 1893, and from that year to the close of 1909 the fatalities have numbered 1,166. The causes of the accidents and the statistics of injuries other than fatal are available only since 1906, when they were first published, the destruction by fire of the records of the mine inspector's office having obliterated all the data which had been collected up to that date. In the four years from 1906 to 1909, inclusive, there were 487 men killed in the coal mines of the State. Falls of roof or coal were the most prolific causes of these casualties, 183 deaths being attributed thereto. Ninety-six men were killed by explosions of dust or gas, 41 by explosions of powder, and 167 by other causes.

The number of mining machines reported in use in 1909 was 283, and the quantity of machine-mined coal produced was 2,203,619 short tons, against 1,783,516 tons by the use of 197 machines in 1908. The percentage of machine-mined coal to the total production was 15.02 in 1909, against 15.37 in 1908. The 283 machines in use in 1909 included 191 of the pick or puncher type, 74 chain machines, 17 longwall, and 1 pick shearing machine. In 1909, of the total quantity of coal produced in Alabama, 5,863,396 short tons were washed at the mines, yielding 5,250,408 tons of cleaned coal and 612,988 tons of refuse. Most of this washed coal is used in the manufacture of coke. There are also some washeries operated in connection with coking plants at points distant from the mines. The coal washed at at such plants is not included in this statement. The difference of approximately 90,000 tons of production, as reported by the State mine inspector and as shown by the returns to the Bureau of the Census and the Geological Survey, is because in several instances the commercial product reported to the mine inspector was the weight of the coal before washing and on the census-survey schedules the weight of the washed coal was given.

The statistics of coal production in Alabama in 1908 and 1909, with the distribution of the product for consumption, are shown in the following table:

Coal production of Alabama in 1908 and 1909, by counties, in short tons.

1908.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Bibb	1,080,432	12,409	73,707		1,166,548	$1,778,008	$1.52	224	2,187
Etowah	7,880	1,000			8,880	11,090	1.25	211	30
Jefferson	3,664,375	54,607	204,799	1,990,348	5,914,129	7,089,173	1.20	239	8,780
St. Clair	179,920	1,261	12,253		193,434	288,737	1.49	156	450
Shelby	382,280	1,938	23,329		407,547	737,714	1.81	201	827
Tuscaloosa	301,080	8,282	25,126	377,613	712,101	966,804	1.36	220	1,288
Walker	2,599,158	53,665	52,654	236,359	2,941,836	3,386,159	1.15	205	4,970
Winston	28,388	20			28,408	49,769	1.75	222	85
Other counties [a]	222,051	2,536	6,473		231,060	339,387	1.47	204	580
Small mines		650			650	1,050	1.62		
Total	8,465,564	136,368	398,341	2,604,320	11,604,593	14,647,891	1.26	222	19,197

1909.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.
Bibb	1,227,614	5,736	104,501	392	1,338,243	$1,791,805	$1.34
Etowah	44,416	238	1,540		46,194	59,869	1.30
Jefferson	3,873,937	106,305	247,099	2,949,581	7,176,922	8,222,061	1.15
St. Clair	336,072	1,336	16,597		354,005	460,640	1.30
Shelby	489,190	3,746	31,989		524,925	838,595	1.60
Tuscaloosa	648,731	9,311	44,431	304,516	1,006,989	1,158,484	1.15
Walker	2,585,006	57,749	82,538	248,483	2,973,776	3,387,988	1.14
Winston	26,578	5,700			32,278	48,489	1.50
Other counties [a]	235,401	6,451	7,806		249,658	337,464	1.35
Small mines		460			460	841	1.83
Total	9,466,945	197,032	536,501	3,502,972	13,703,450	16,306,236	1.19

[a] Blount, Cullman, Dekalb, Jackson, and Marion.

In the following table is presented a statement of the production of coal in Alabama, by counties, during the last five years, with increase in 1909 as compared with 1908:

Coal production of Alabama, 1905–1909, by counties, in short tons.

County.	1905.	1906.	1907.	1908.	1909.	Increase (+) or decrease (−), 1909.
Bibb	1,335,923	1,324,656	1,297,158	1,166,548	1,338,243	+ 171,695
Blount, Cullman	[a] 294,550	337,848	336,308	181,062	186,261	+ 5,199
Etowah	170,484	133,660	205,015	8,880	46,194	+ 37,314
Jefferson	5,873,268	6,623,115	7,526,275	5,914,129	7,176,922	+1,262,793
St. Clair	186,595	256,227	283,806	193,434	354,005	+ 160,571
Shelby	157,569	225,087	245,087	407,547	524,925	+ 117,378
Tuscaloosa	885,361	1,050,792	1,047,364	712,101	1,006,989	+ 294,888
Walker	2,845,617	3,062,518	3,254,919	2,941,836	2,973,776	+ 31,940
Winston	40,109	27,076	35,333	28,408	32,278	+ 3,870
Other counties and small mines	76,593	[b] 66,984	19,189	50,648	63,857	+ 13,209
Total	11,866,069	13,107,963	14,250,454	11,604,593	13,703,450	+2,098,857
Total value	$14,387,721	$17,514,786	$18,405,468	$14,647,891	$16,306,236	+$1,658,345

[a] Includes production of Marion County. [b] Includes Dekalb and Jackson counties.

So far as known the earliest record of the existence of coal in Alabama was made in 1834. The first statement of production in the State is contained in the United States census report for 1840, in which year the production is given as 946 tons. The census report for 1850 does not mention any coal production for the State, and the next authentic record is contained in the census statistics of 1860, when Alabama is credited with an output of 10,200 short tons. The mines of Alabama were probably worked to a considerable extent during the civil war, but there are no further records of the actual production until 1870, for which year the United States census reports a production of 11,000 tons. Ten years later the production had increased to 323,972 short tons, but the development of the present great industry really began in 1881 and 1882, when attention was directed to the large iron deposits near the city of Birmingham, and thus the great "boom" of that city and vicinity was inaugurated. By 1885 the coal production of the State had increased to nearly 2,500,000 tons. Then followed a period of relapse and liquidation, which lasted for two years, after which business settled down to a conservative and rational basis and has since developed steadily. In 1902 the coal production of the State reached a total of over 10,000,000 tons, and reached the maximum of 14,250,454 tons in 1907.

The statistics of production in Alabama from 1840 to the close of 1909 are found in the following table:

Production of coal in Alabama from 1840 to 1909, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1840	916	1858	8,500	1876	112,000	1894	4,397,178
1841	1,000	1859	9,000	1877	196,000	1895	5,693,775
1842	1,000	1860	10,200	1878	224,000	1896	5,748,697
1843	1,200	1861	10,000	1879	280,000	1897	5,893,770
1844	1,200	1862	12,500	1880	323,972	1898	6,535,283
1845	1,500	1863	15,000	1881	420,000	1899	7,593,416
1846	1,500	1864	15,000	1882	896,000	1900	8,394,275
1847	2,000	1865	12,000	1883	1,568,000	1901	9,099,052
1848	2,000	1866	12,000	1884	2,240,000	1902	10,354,570
1849	2,500	1867	10,000	1885	2,492,000	1903	11,654,324
1850	2,500	1868	10,000	1886	1,800,000	1904	11,262,046
1851	3,000	1869	10,000	1887	1,950,000	1905	11,866,069
1852	3,000	1870	11,000	1888	2,900,000	1906	13,107,963
1853	4,000	1871	15,000	1899	3,572,983	1907	14,250,454
1854	4,500	1872	16,800	1890	4,090,409	1908	11,604,593
1855	6,000	1873	44,800	1891	4,759,781	1909	13,703,450
1856	6,800	1874	50,400	1892	5,529,312		
1857	8,000	1875	67,200	1893	5,136,935	Total	190,042,353

ALASKA.[a]

Though something has been known of Alaska coal for more than sixty years, the amount of actual mining has been insignificant. The total production since the Territory was acquired from Russia is less than 50,000 tons. This is all the more significant because during this time more than a million and a half tons of coal have been shipped to Alaska, all but about 20 per cent of which was brought from foreign fields.

The following table shows the annual coal production since 1897 and an estimate of the output between 1888 and 1897. A little coal was mined previous to 1884 by the crews of vessels that ran short of fuel, but this probably did not aggregate more than a few hundred tons. The total output of coal previous to 1889, including that mined by the Russians, was probably less than 10,000 tons:

Production of coal in Alaska, 1888–1909.

Year.	Amount (short tons).	Value.	Year.	Amount (short tons).	Value.
1888-1896	6,000	$84,000	1904	1,694	$7,225
1897	2,000	28,000	1905	3,774	13,250
1898	1,000	14,000	1906	5,541	17,974
1899	1,200	16,800	1907	10,139	53,600
1900	1,200	16,800	1908	3,107	14,810
1901	1,300	15,600	1909	2,800	12,300
1902	2,212	19,048			
1903	1,447	9,782	Total	43,414	323,189

NOTE.—The production for 1888–1896 is estimated on the best data obtainable. The figures for 1897 to 1908 are based for the most part on data supplied by operators; those for 1909 on preliminary estimates.

Several of the first explorers of the Alaska coast noted the presence of coal on Cook Inlet, where, too, the first attempts at mining were made. In 1854 an American company[b] under a Russian charter opened a coal mine at Port Graham, on Cook Inlet, and this mine continued to supply Russian steamers with fuel until the transfer of the Territory. The demand for fuel due to the rapid increase in the population of California was the first incentive to a systematic search for coal in Alaska. In the early seventies coal lands were staked on Unga Island, and during the next thirty years a number of companies were organized for the purpose of exploiting the coal of Cook Inlet and the Alaska Peninsula region. Up to 1896, however, nothing notable was accomplished either in mining or in prospecting, though some mining had been done at Kachemak Bay, Chignik, and Herendeen Bay, on Admiralty Island, and

[a] Extract from United States Geological Survey Bulletin No. 442: Alaska coal and its utilization, by Alfred H. Brooks.

[b] This company was first organized to supply ice to California from Alaskan glaciers.

along Yukon River. Coal mining lagged in Alaska chiefly because the Pacific coast markets were supplied from the rapidly developing fields of Washington, California, and Vancouver Island.

It appears to have been about 1896 that the Bering River field first attracted the notice of prospectors, and about two years later the Matanuska field was found. By 1901 prospectors had begun to recognize the importance of these two fields. It was not, however, until after the examination and reports by the Geological Survey (1904–1908) that the public outside of Alaska began to realize that these fields contained a large quantity of high-grade fuel.

Meanwhile the exodus to Alaska which took place from 1897 to 1900, because of the placer-gold discoveries, had much increased the local demand for fuel. Several mines were then opened on the Yukon, intended to supply coal to river steamers. Most of these enterprises were abandoned when petroleum engines were substituted for coal burners in 1902. An enterprise which had for its purpose the shipping of coal to Nome from the Cape Lisburne fields was equally unsuccessful. More important was the opening of a coal mine on Chicago Creek, in the northeastern part of Seward Peninsula. This mine began to supply the neighboring placer camps with fuel in 1903 and has been in operation every winter since that time. A second mine was opened in 1909. These enterprises indicate the value of the lignite deposits for local industries. Mining in a small way has also continued to the present day at several localities on the Pacific seaboard, and more intermittently on the Yukon and at Cape Lisburne. In 1906–7 a few thousand tons of coal was mined on Bering Lake, being used in the railway construction work of the vicinity. This is the only mining that has been done in either of the two most important coal fields.

Two influences have held back the development of the Bering River and Matanuska fields. One was the advances made in the California oil districts, and the other the unfortunate conditions existing in regard to the laws under which Alaska coal lands can be taken up.

During the decade ending with the year 1908 the annual output of the California oil fields increased from about 2,500,000 to nearly 45,000,000 barrels. As probably 80 per cent of this petroleum is used for fuel in the Pacific coast States, it has to a corresponding extent decreased the demand for coal.

A far more serious handicap has been the coal-land laws. Though laws intended to enable the individual to obtain title to coal lands have been on the statute books for the last decade, not a single acre of land has yet (July 1, 1910) gone to patent. It is therefore not surprising that progress has been checked in the coal fields and that many who would undertake their development have become discouraged.

The first act, passed June 6, 1900, simply extended to Alaska the provisions of the coal-land laws in the United States. This law was ineffective, for it provided that only subdivided lands could be taken up, and there were then no land surveys in Alaska. The matter was rectified by the act of April 28, 1904,[a] which permitted unsurveyed lands to be entered and the surveys to be made at the expense of the entrymen. Unfortunately the law provided that only tracts of 160 acres could be taken up, and no recognition was given to the fact that it was impracticable to develop an isolated coal field requiring the expenditure of a large amount of money by such small units. Many claims were staked, however, and surveys were made for patents. It was recognized by everybody familiar with the conditions that after patent was obtained these claims would be combined in tracts large enough to assure successful mining operations. No one experienced in mining would, of course, consider it feasible to open a coal field on the basis of single 160-acre tracts. The claims for the most part were handled in groups, for which one agent represented the several different owners. Unfortunately, a strict interpretation of the statute raised the question whether even a tacit understanding between claim owners to combine after patents had been obtained was not illegal. Remedial legislation was sought and enacted in the statute of May 28, 1908. This law [b] permitted the consolidation of claims staked previous to November 12, 1906,[c] in tracts of 2,560 acres. One clause of this law invalidated the title if any individual or corporation at any time in the future owned any interest whatsoever, directly or indirectly, in more than one tract. The purpose of this clause was to prevent the monopolization of coal fields; its immediate effect was to discourage capital. It was felt by many that this clause might lead to forfeiture of title through the accidents of inheritance or might even be used by the unscrupulous in blackmailing. It would appear that land taken up under this law might at any time be forfeited to the Government through the action of any individual who, innocently

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[a] A complete statement of the Alaska coal-land situation is contained in the testimony of Frederick Dennett, Commissioner of the General Land Office, in hearings before the Committee to Investigate the Interior Department and Forest Service, vol. 5, 1910, pp. 4298–4391.

[b] See Opinion of the Attorney-General, dated June 12, 1909, expressed in letter to the Secretary of the Interior, Senate Doc. 248, 61st Cong., 2d sess., 1910.

[c] All coal lands of Alaska have been withdrawn from location and entry since November 12, 1906.

or otherwise, obtained interest in more than one coal company. Such a title was felt to be too insecure to warrant the large investments needed for mining developments.

The net result of all this is that no titles to coal lands have been passed. Meanwhile, a popular clamor has been raised indiscriminately against all Alaska coal claimants. The practice of locating coal lands through power of attorney, which is stictly legal and universally accepted in all mining law, has been confused with the so-called "dummy entrymen" practice, which is illegal. It is true that many of the coal-land claimants are nonresidents, yet this is necessarily so, for the man who has the means necessary to provide for a survey, payments to the Government, and the development work on a claim required before patent is issued usually does not follow the vocation of a prospector. The difference between the mining of coal and the mining of placer gold has not always been recognized. A placer claim may yield a profit to the prospector who has but a supply of provisions and a few simple tools, but as a necessary preliminary to coal mining at least several thousand dollars must be expended on each claim. Even after the money necessary to patent has been spent, no profit from mining can accrue until sufficient capital has been invested to provide equipment and transportation facilities. These explanations, obvious to every coal miner, are made here because an idea seems prevalent that any individual prospector, after staking a coal claim, can proceed to develop it at a profit as he might a gold placer.

ARKANSAS.

Total production in 1909, 2,377,157 short tons; spot value, $3,523,139.

Coal production in Arkansas was not influenced by any marked changes in trade conditions in 1909 as compared with 1908. In neither year was the business satisfactory to the operators or to the miners. Competition with petroleum and natural gas, resulting from the developments in the Louisiana and the Mid-Continent field, has adversely affected the markets for coal and in addition to this whatever benefit might have been gained in 1909 through the recovery from the depression in 1908 was largely offset by a drought which lasted from the first of June to the middle of November. The drought caused a great scarcity of water at the mines and increased the cost of production by the additional expense of providing water for the boilers. It also created a crop shortage, which in turn affected the demand for fuel.

In addition to these unfavorable features, it is reported that as a result of an injunction prohibiting the railroad commission of Arkansas from enforcing the state freight rates, the railroads have materially advanced their rates on Arkansas coal to points in the eastern part of the State, the advance having the effect of increasing the sale of Illinois coal in Arkansas. The markets for Arkansas coal have, indeed, for some time been growing more and more restricted and localized, so that any expansion in the production of coal must depend upon increased population and industrial development in a comparatively small area.

There was no shortage of labor at the Arkansas mines, operators having had more difficulty in providing steady employment for their employees than in securing labor for the work to be done. There was little idleness due to strikes or other labor trouble.

Compared with the production of coal in Arkansas in 1908, which amounted to 2,078,357 short tons, valued at $3,499,470, the output in 1909 showed an increase of 298,800 short tons, or 13.9 per cent, in quantity, and of $23,669, or 0.7 per cent, in value. In 1907, the year of maximum production in the State, the quantity of coal mined exceeded that of 1909 by 293,281 short tons, with an excess in value of $950,554. The effect of the competition of oil and gas with Arkansas coal is shown by the decline in the average price per ton, from $1.68 in 1907 and 1908 to $1.48 in 1909.

There are no mining machines in use in the State.

Owing to the frequent changes in the office of mine inspector, the statistics of accidents in the coal mines of Arkansas have been irregularly compiled. In both 1907 and 1909 the accident statistics were collected for six months only, and complete statistics for but two years, 1906 and 1908, have been published. In the last six months of 1909, according to Mr. James Douglas, the present inspector, there were 12 men killed and 34 injured in the coal mines of the State. One half of the fatalities were due to gas or dust explosions, 3 to powder explosions or windy shots, and 3 to other causes.

The statistics of production, by counties, for the last two years, with the distribution of the product for consumption, are shown in the following table:

Coal production of Arkansas in 1908 and 1909, by counties, in short tons.

1908.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Franklin	196,334	875	6,103	203,312	$316,140	$1.55	87	781
Johnson	191,038	2,345	4,300	197,683	407,874	2.06	97	738
Logan	27,754	1,822	1,147	30,723	72,844	2.37	124	171
Sebastian	1,524,610	7,121	49,047	1,580,778	2,520,225	1.59	171	3,280
Other counties[a] and small mines	51,452	2,630	11,779	65,861	182,387	2.77	149	367
Total	1,991,188	14,793	72,376	2,078,357	3,499,470	1.68	145	5,337

1909.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Franklin	263,976	2,614	14,809	281,399	$385,887	$1.37	....	....
Johnson	161,758	1,792	7,552	171,102	344,972	2.02	....	....
Logan	21,421	2,432	1,316	25,169	64,160	2.55	....	....
Sebastian	1,754,057	5,357	59,367	1,818,781	2,490,458	1.37	....	....
Other counties[a] and small mines	68,994	3,853	7,859	80,706	237,662	2.94	....	....
Total	2,270,206	16,048	90,903	2,377,157	3,523,139	1.48	....	5,266

[a] Pope, Scott, and Washington.

A statement of the production of coal in Arkansas, by counties, for the last five years, with increase and decrease in 1909 as compared with 1908, are shown in the following table:

Coal production of Arkansas, 1905–1909, by counties, in short tons.

County.	1905.	1906.	1907.	1908.	1909.	Increase (+) or decrease (−), 1909.
Franklin Johnson	[a] 634,618	[a] 489,434	[a] 666,735	[a] 400,995	[a] 452,501	+ 51,506
Logan	26,090	26,647	29,970	30,723	25,169	− 5,554
Pope	39,685	34,776	47,753	35,481	56,344	+ 20,863
Sebastian	1,189,455	1,278,497	1,875,386	1,580,778	1,818,781	+238,003
Other counties and small mines	44,825	34,914	50,594	30,380	24,362	− 6,018
Total	1,934,673	1,864,268	2,670,438	2,078,357	2,377,157	+298,800
Total value	$2,880,738	$3,000,339	$4,473,693	$3,499,470	$3,523,139	+ 23,669

[a] Includes Johnson County.

According to the United States census for 1840, a small quantity of coal (220 short tons) was mined in Arkansas during that year. With the exception of 9,972 short tons mined in Missouri and 400 tons from Iowa mines, this was the only coal produced west of Mississippi River in that year, and for the next twenty years these were the only States west of the Mississippi from which any coal production was reported. The industry in Arkansas did not develop rapidly during the earlier years, as the census of 1860 shows a production of only 200 tons, and that of 1880 a total of 14,778 short tons. During the last twenty years, with the exception of 1904, 1905, 1906, and 1908, the production has increased quite rapidly, reaching a maximum of 2,670,438 short tons in 1907.

A statement of the annual production of coal in Arkansas from 1840 to the close of 1909 will be found in the following table:

Production of coal in Arkansas from 1840 to 1909, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1840	220	1887	129,600	1896	675,374	1905	1,934,673
1860	200	1888	276,871	1897	856,190	1906	1,864,268
1880	14,778	1889	279,584	1898	1,205,479	1907	2,670,438
1881	20,000	1890	399,888	1899	843,554	1908	2,078,357
1882	25,000	1891	542,379	1900	1,447,945	1909	2,377,157
1883	50,000	1892	535,558	1901	1,816,136		
1884	75,000	1893	574,763	1902	1,943,932	Total	28,211,915
1885	100,000	1894	512,626	1903	2,229,172		
1886	125,000	1895	598,322	1904	2,009,451		

CALIFORNIA.

Total production in 1909, 45,836 short tons; spot value, $95,042.

California showed a larger percentage of increase in coal production in 1909 over the output of 1908 than any other State in the Union. The quantity produced increased from 18,755 short tons in 1908 to 45,836 short tons in 1909, a gain of 27,081 short tons, or 144.4 per cent. The value increased $40,202, or 73.3 per cent, from $54,840 in 1908 to $95,042 in 1909. The increase in production and the comparatively lower value in 1909 were both due entirely to the operations of the Stone Cañon Consolidated Coal Company, in Monterey County. This company had expended large amounts of money during the two preceding years in development work and in putting the plant on a basis for extensive operations. Unfortunately, because of faults encountered in the development work and the inability to obtain efficient labor, the expenses incurred largely exceeded the original estimated cost. In addition to these misfortunes, after the plant was completed and 25 miles of railroad to the Southern Pacific tracks were constructed, heavy floods and cloudbursts so damaged the properties that the resources of the company were exhausted in making the repairs, and as the company was unable to procure additional funds the work had to be abandoned. A receiver for the company was appointed in October, 1909, since which time the works have been shut down. In the nine months from January to September, however, this company had shipped more than 75 per cent of the total output of the State for the entire year. In addition to the other difficulties the output of the Stone Canyon mines came into competition with a large supply of Australian coal which was forced on the market at lower prices than had been known in San Francisco up to that time or have been known since.

The remainder of the production in 1909 was from Amador and Riverside counties, principally from Ione in Amador County. All of this was lignite. The Stone Canyon product is a true bituminous coal, and with favorable freight rates should compete successfully for domestic purposes with foreign coals in the markets of San Francisco and other cities of the State. The enormous increase in the production of petroleum in California and the use of that product by the transportation and manufacturing industries has practically eliminated coal as a steam-raising fuel in the State. Development of other bituminous coal properties in Monterey and San Benito counties has been held back on this account.

The production of crude petroleum in California increased from 33,098,598 barrels in 1906 to 39,748,375 barrels in 1907, to 44,854,737 barrels in 1908, and to 54,433,010 barrels in 1909. By far the larger part of this product is used as fuel, and estimating 3.5 barrels of petroleum as equivalent in efficiency for fuel to 1 ton of coal, the total production of California petroleum in 1909 was equivalent to over 15,500,000 tons of bituminous coal. California's petroleum production in 1909 was larger than the entire output of the United States in any year prior to 1896. Petroleum is a more desirable steam-raising fuel than coal, for it makes no dust and cinders, requires no fireman, and leaves no ashes to be disposed of. Under the circumstances it is not remarkable that coal mining in the State is at a disadvantage.

The statistics of coal production in California during the last five years, with the distribution of the product for consumption, are shown in the following table:

Distribution of the coal product of California, 1905–1909, in short tons.

Year.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
1905	74,000	550	2,500	77,050	$382,725	$4.97	294	135
1906	7,040	15,250	3,000	[a] 25,290	60,710	2.40	284	41
1907	7,910	2,680	3,360	13,950	38,213	2.74	258	32
1908	12,400	1,955	4,400	18,755	54,840	2.93	250	34
1909	34,888	3,297	7,651	45,836	95,042	2.07	....	14

[a] In addition to this total there were 6,910 tons of bituminous coal mined in Monterey County, but not shipped during the year.

The records of the State Mining Bureau of California show a production of coal in that State as early as 1861. It was at that time one of the sixteen coal-producing States. During the later part of that decade and throughout the following decade the production of California exceeded 100,000 tons annually and reached a maximum of 237,000 tons in 1880. Since 1881 the production has been irregular, having been largely influenced by the imports of Australian and British Columbia coals. The receipts of Australian coal have depended principally upon the wheat production and shipments from the Pacific coast. Vessels bringing Australian coal as return cargoes have had very low freight rates.

The history of the coal-mining industry in California from 1861 to the close of 1909 is exhibited in the following table:

Production of coal in California from 1861 to 1909, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1861	6,620	1874	215,352	1887	50,000	1900	171,708
1862	23,400	1875	166,638	1888	95,000	1901	151,079
1863	43,200	1876	128,049	1889	119,820	1902	84,984
1864	50,700	1877	107,789	1890	110,711	1903	104,673
1865	60,530	1878	134,237	1891	93,301	1904	78,888
1866	84,020	1879	147,879	1892	85,178	1905	77,050
1867	124,690	1880	236,950	1893	72,603	1906	25,290
1868	143,676	1881	140,000	1894	67,247	1907	13,950
1869	157,234	1882	112,592	1895	75,453	1908	18,755
1870	141,890	1883	76,162	1896	78,544	1909	45,836
1871	152,493	1884	77,485	1897	87,992		
1872	190,859	1885	71,615	1898	145,888	Total	5,095,536
1873	186,611	1886	100,000	1899	160,915		

COLORADO.

Total production in 1909, 10,716,936 short tons; spot value, $14,296,012.

Since 1899, or for the last ten years, Colorado has occupied first place among the coal-producing States west of Mississippi River and ranks seventh among all the States. It possesses, particularly in Las Animas County, large supplies of coal that yield a good quality of coke, and the State is assuming considerable importance in the manufacture of iron and steel. Among the coal-producing counties Las Animas is by far the most important, contributing nearly one-half the total output of the State. In 1909, out of a total of 10,716,936 short tons, Las Animas County yielded 4,592,964 tons.

Colorado's output of coal in 1909 exceeded that of 1908 by 1,081,963 short tons and was within less than 75,000 tons of the maximum record of 1907. The value of the product in 1909 increased $709,024 over 1908, the gain in value being considerably less relatively than the increase in production. The percentage of increase in quantity was 11.2, but the value showed a gain of only 5.2 per cent. The average price per ton declined from $1.41 in 1908 to $1.33 in 1909. This decline and the smaller proportionate gain in value as compared with the increase in production can scarcely be attributed to generally unsatisfactory trade conditions, for in its coal-mining regions Colorado, like the other Rocky Mountain States, benefited by the increased activity in metal mining and by the general prosperity in the agricultural districts. Colorado operators have, however, been reaching out for trade in the rapidly developing sections to the southeast in Texas and Oklahoma, and to meet the competition of other coals in these markets probably have had to make some concessions in price. Competition for the Denver trade among producers of subbituminous coal in the Denver region has also been rather keen, as is shown by the fact that the average price per ton in Boulder County declined from $1.44 in 1908 to $1.29 in 1909, and that in Weld County declined from $1.56 to $1.31.

The principal increases in the quantity of coal produced in 1909 were in the three most important producing counties. Las Animas County, which contributes over 40 per cent of the total output of the State, was credited with a gain of 402,163 short tons, or nearly 40 per cent of the total increase in 1909. The production in Las Animas County is from the Trinidad-Raton coal field, which also furnishes the larger part of the output of New Mexico. The Walsenburg district, which is at the northern end of the Trinidad-Raton region, in Huerfano County, showed an increase of 271,842 short tons; and Boulder County, which supplies a large part of the domestic trade in Denver, increased 264,374 short tons. Probably the most significant increase, however, as indicating the possibilities of activities in the near future, was that of 600 per cent in the production of Routt County, from 13,005 tons in 1908 to 92,439 tons in 1909. There is good reason to believe that with the completion of the Denver, Northwestern and Pacific Railway, "the Moffat road," from Denver to Salt Lake City, this county in the far northwest corner of the State will become one of the most important coal-producing districts of Colorado. There were five counties in which the coal production in 1909 was less than in 1908. The largest decreases were in Pitkin County (69,075 tons) and in Fremont County (57,294 tons).

The only exceptions in 1909 to an otherwise absolutely peaceful year, so far as labor difficulties were concerned, were two strikes, both of which were insignificant in their effect upon production. In one of these 40 men were idle twenty days, and in the other 15 men were idle thirty days.

The use of machines for mining coal in Colorado has increased steadily and significantly in the last few years. In 1909 the total number of machines reported as in use in the coal mines of the State was 253, an increase of 42 over 1908 and of 78 over 1907. The quantity of coal mined by machines increased from 1,668,602 short tons in 1908 to 1,929,545 short tons in 1909, in which latter year the percentage of machine-mined coal to the total output was 18, as compared with 17.32 in 1908 and with 15.66 in 1907. Of the 253 machines used in 1909, there were 168 pick undercutting machines, 63 chain-breast machines, and 12 long-wall machines. Ten machines were used for shearing, of which 7 were pick and 3 were chain.

Of the total production in 1909, 425,561 short tons of raw coal were washed before being sold or used. The product from the machines consisted of 318,939 tons of cleaned coal and 106,622 tons of refuse. These figures were less than those reported in 1908, when 449,320 tons were washed, yielding 336,123 tons of cleaned coal and 113,197 tons of refuse. All of the coal washed is slack, and is used in the manufacture of coke.

Complete records of the accidents in the coal mines of Colorado have been kept since 1884. During this quarter of a century 1,168 men were killed, and 2,630 were injured. Of these, gas and dust explosions killed 275 and injured 165; explosions of powder and windy shots killed 35 and injured 90; falls of roof and coal killed 640 and injured 1,338; and 218 deaths and 837 injuries were due to miscellaneous causes. In 1909 there were 95 fatal accidents, an increase of 50 per cent over 1908. The nonfatal accidents in 1909 numbered 116, as against 115 in 1908. Of the fatal accidents in 1909, 15 were due to gas and dust explosions, 64 were due to falls of roof and coal, and the others were due to miscellaneous causes. According to the report of Mr. John D. Jones, state mine inspector of Colorado, the production of coal in 1909 amounted to 10,736,459 short tons, in the mining of which 13,156 men were employed. This shows that 113,015 tons were mined for each life lost, and that the death rate per thousand was 7.22. In 1908 there were 157,950 tons mined for each life lost, and the death rate per thousand was 4.2. The difference between the figures of production reported by Mr. Jones and those reported to the Bureau of the Census and the Geological Survey was less than 20,000 tons, which in a total of over 10,000,000 tons is so small that it attests the accuracy of both records. The following table shows the number of men killed and injured in the coal mines of Colorado, with the principal causes of the accidents, since 1884:

Number of men killed and injured in coal mines of Colorado and principal causes of accidents, 1884–1909.

Year.	Gas and dust explosions.		Powder explosions and windy shots.		Falls of roof or coal.		Other causes.		Total.	
	Killed.	Injured.	Killed.	Injured.	Killed.	Injured.	Killed.	Injured.	Killed.	Injured.
1884 [a]	60	5	0	1	5	23	1	14	66	43
1885	1	5	0	4	4	36	4	17	9	62
1886	0	1	1	2	4	13	1	32	6	48
1887 [b]	0	1	1	4	8	28	1	19	10	52
1888	8	27	1	2	14	33	6	17	29	79
1889	0	0	0	6	8	64	15	28	23	98
1890	2	4	1	1	10	53	3	26	16	84
1891	2	1	2	4	23	79	3	46	30	130
1892	4	2	2	5	21	78	7	40	34	125
1893	0	6	0	1	16	70	[c] 30	53	46	130
1894	1	6	1	0	13	64	4	90	19	160
1895	4	3	2	3	12	69	5	38	23	113
1896	49	5	0	0	17	37	2	17	68	59
1897	12	2	0	2	18	24	5	26	35	54
1898	0	2	0	3	17	40	7	27	24	72
1899	0	6	0	6	31	57	11	39	42	108
1900	0	15	0	0	24	40	5	15	29	70
1901	10	24	1	2	29	38	15	17	55	81
1902	22	6	3	8	42	62	6	29	73	105
1903	1	3	4	5	31	55	4	47	40	110
1904	19	4	4	13	53	63	13	38	89	118
1905	0	0	2	0	41	0	16	0	59	[d] 100
1906	35	11	4	9	44	105	5	35	88	160
1907	25	5	3	6	52	80	19	47	99	138
1908	5	8	2	1	39	57	15	49	61	115
1909	15	13	1	2	64	70	15	31	95	116
Total	275	165	35	90	640	1,338	218	837	1,168	2,530

[a] Fiscal year.
[b] Calendar year.
[c] Includes 24 men killed in King mine of the Union Pacific Coal Company. Cause of accident not given.
[d] Causes of nonfatal accidents not reported.

The statistics of production in Colorado in 1908 and 1909, with the distribution of the production for consumption, are shown in the following table:

Coal production of Colorado in 1908 and 1909, by counties, in short tons.

1908.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Boulder	1,007 230	14,766	45 952	....	1,067,948	$1,535,810	$1.44	162	1,337
Delta	31,842	5,737	110	....	37,689	66,421	1.76	191	69
El Paso	221,451	86,250	10,062	....	317,763	427,502	1.35	241	364
Fremont	622,484	15,483	31,307	....	669,274	1,471,164	2.20	206	1,416
Garfield	215,412	2,881	1,776	30	220,099	274,633	1.25	184	332
Gunnison	462,103	1,745	14,524	24,768	503,140	801,661	1.59	215	697
Huerfano	1,568,469	7,566	68,033	....	1,644,068	2,644,508	1.61	210	2,808
La Plata	154,170	10,864	1,056	....	166,090	300,317	1.81	196	312
Las Animas	2,922,135	33,658	121,558	1,113,450	4,190,801	4,854,651	1.16	227	6,047
Mesa	42,900	15,350	1,000	....	59,250	99,275	1.68	171	99
Routt	10,180	2,825	....	....	13,005	20,595	1.58	180	8
Weld	296,463	35,066	11,885	....	343,414	535,958	1.56	204	494
Other counties[a]	231,583	10,322	23,841	133,706	399,452	548,452	1.37	218	540
Small mines	....	2,980	....	....	2,980	6,041	2.02	....	....
Total	7,786,422	245,493	331,104	1,271,954	9,634,973	13,586,988	1.41	212	14,523

1909.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Boulder	1,271,387	15,717	45,218	....	1,332,322	$1,714,415	$1.29	....	....
Delta	46,322	8,509	200	....	55,031	96,445	1.75	....	....
El Paso	192,471	110,120	9,642	....	312,233	409,971	1.31	....	....
Fremont	573,246	13,845	24,889	....	611,980	1,355,904	2.22	....	....
Garfield	250,422	2,600	4,744	30	257,796	336,190	1.30	....	....
Gunnison	526,537	4,750	16,852	50,324	598,463	894,904	1.50	....	....
Huerfano	1,845.252	6,689	63,969	....	1,915,910	3,034,171	1.58	....	....
La Plata	135,927	2,477	1,454	....	139,858	243,906	1.74	....	....
Las Animas	2,947,356	33,208	124,472	1,487,928	4,592,964	4,971,073	1.08	....	....
Mesa	83,510	13,137	1,594	....	98,241	165,432	1.68	....	....
Routt	89,292	778	2,369	....	92,439	154,953	1.68	....	....
Weld	278,314	30,161	19,070	....	327,545	428,270	1.31	....	....
Other counties[b]	221,940	8,468	15,269	118,437	364,114	458,836	1.26	....	....
Small mines	....	18,040	....	....	18,040	31,542	1.75	....	....
Total	8,461,976	268,499	329,742	1,656,719	10,716,936	14,296,012	1.33	....	11,472

a Archuleta, Douglas, Jefferson, Larimer, Montezuma, Pitkin, and Rio Blanco.
b Archuleta, Jefferson, Montezuma, Pitkin, and Rio Blanco.

The following table shows the total production of the State, by counties, during the last five years, with increase and decrease in 1909 as compared with 1908:

Coal production in Colorado, 1905–1909, by counties, in short tons.

County.	1905.	1906.	1907.	1908.	1909.	Increase (+) or decrease (−), 1909.
Boulder	839,804	1,022,096	1,296,729	1,067,948	1,332,322	+ 264,374
Delta	9,497	6,812	22,087	37,689	55,031	+ 17,342
El Paso	188,775	210,793	269,795	317,763	312,233	− 5,530
Fremont	512,002	666,034	784,949	669,274	611,980	− 57,294
Garfield	172,563	193,063	220,040	220,099	257,796	+ 37,697
Gunnison	513,317	583,175	576,859	503,140	598,463	+ 95,323
Huerfano	1,426,640	1,803,791	1,797,790	1,644,068	1,915,910	+ 271,842
Jefferson	189,235	212,037	193,814	163,624	195,809	+ 32,185
La Plata	168,669	173,720	184,018	166,090	139,858	− 26,232
Las Animas	4,297,599	4,768,882	4,885,105	4,190,801	4,592,964	+ 402,163
Pitkin	342,804	319,529	313,866	228,828	159,753	− 69,075
Routt	3,643	5,297	5,690	13,005	92,439	+ 79,434
Weld	101,812	95,420	136,074	343,414	327,545	− 15,869
Other counties	60,069	50,569	103,420	69,230	124,833	+ 55,603
Total	8,826,429	10,111,218	10,790,236	9,634,973	10,716,936	+1,081,963
Total value	$10,810,978	$12,735,616	$15,079,449	$13,586,988	$14,296,012	+ $709,024

Coal mining as an industry in Colorado began in 1864, a production of 500 short tons being recorded for that year. In 1876 the production reached for the first time a total exceeding 100,000 tons, and six years later, in 1882, had reached the million-ton mark. Since that date the increase has been almost uninterrupted, there being only four times (in 1884, 1894, 1904, and 1908) when the production showed a decrease of any importance, and only five times altogether in thirty-eight years. The largest decrease was in the "hard-times" year, 1894. The coal production of the State exceeded 3,000,000 tons in 1890; ten years later it had grown to over 5,000,000 tons, and it amounted to nearly 11,000,000 tons in 1907 and 1909.

The record by years since 1864 is shown in the following table:

Production of coal in Colorado from 1864 to 1909, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1864	500	1876	117,666	1888	2,185,477	1900	5,244,364
1865	1,200	1877	160,000	1889	2,597,181	1901	5,700,015
1866	6,400	1878	200,630	1890	3,077,003	1902	7,401,343
1867	17,000	1879	322,732	1891	3,512,632	1903	7,423,602
1868	10,500	1880	462,747	1892	3,510,830	1904	6,658,355
1869	8,000	1881	706,744	1893	4,102,389	1905	8,826,429
1870	4,500	1882	1,061,479	1894	2,831,409	1906	10,111,218
1871	15,600	1883	1,229,593	1895	3,082,982	1907	10,790,236
1872	68,540	1884	1,130,024	1896	3,112,400	1908	9,634,973
1873	69,997	1885	1,356,062	1897	3,361,703	1909	10,716,936
1874	77,372	1886	1,368,338	1898	4,076,347		
1875	98,838	1887	1,791,735	1899	4,776,224	Total	133,020,245

GEORGIA.

Total production in 1909, 211,196 short tons; spot value $298,792.

Coal production in Georgia, which has shown a decreasing tendency since 1903, suffered a further decline in 1909. Compared with 1908 the output in 1909 showed a decrease of 53,626 short tons, or 20 per cent in quantity and of $65,487, or 18 per cent in value. With one exception, 1891, the production in 1909 was the smallest in a period of twenty years. It was only a little more than half the output in 1903, when the maximum production for any one year, 416,951 short tons, was made. The production in 1908 was nearly 100,000 tons less than in 1907. The decrease in both 1908 and 1909 was due to the withdrawal by the State of the convicts who were employed as miners under lease and to the inability of the operators to secure enough labor to keep the mines up to capacity. A partial offset to the decreased production is noted in the larger relative returns to the operators as shown by the advance in the average price per ton from $1.22 in 1904 to $1.28 in 1906, $1.38 in 1907 and 1908, and $1.41 in 1909, though this benefit is in turn mitigated by the fact that decreased production is necessarily attended with an increased cost per unit of output.

All of the coal produced in Georgia is hand-mined, no undercutting machines being employed. At one establishment the slack coal used in the manufacture of coke is washed before being charged into the ovens. In 1909, 94,300 short tons of this coal was washed, yielding 85,290 tons of cleaned coal and 9,010 tons of refuse.

During 1909 there were 2 fatal and 56 nonfatal accidents in the coal mines of Georgia. Both of the fatal and 22 of the nonfatal accidents were due to falls of roof or coal. Three men were injured (none fatally) by explosions of powder, and 31 injuries were due to miscellaneous causes. There was no explosion of gas or dust in the mines.

The statistics of the production of coal for the last five years, with the distribution of the product for consumption, are shown in the following table:

Coal production of Georgia, 1905–1909, in short tons.

Year.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
1905	224,695	1,148	7,113	119,035	351,991	$453,848	$1.29	270	801
1906	194,881	850	8,324	128,052	332,107	424,004	1.28	279	737
1907	204,890	5,780	10,700	141,031	362,401	499,686	1.38	262	808
1908	184,040	930	8,400	71,452	264,822	364,279	1.38	261	670
1909	119,806	1,000	4,100	86,290	211,196	298,792	1.41		460

Portions of two counties in the extreme northwestern corner of Georgia are underlain by the coal measures of the southern Appalachian coal fields. The Walden basin of Tennessee crosses Dade County, in Georgia, and extending southwest becomes the Blount Mountain and the Warrior basins in Alabama. The Lookout basin, a narrow outlying area, extends from Etowah County, in Alabama, in a northeast direction into Walker County, in Georgia. The total area of the coal fields in Georgia is estimated at 167 square miles, the smallest of all the state coal fields, not all of it being workable. All of the coal mined in Georgia is high-grade bituminous and enjoys an enviable reputation as a steam fuel. As bunker coal it has no superior in the South Atlantic States. It also makes excellent coke, and about 30 per cent of the output is made into coke which is sold to the furnaces at Chattanooga and other points in Tennessee and Georgia.

The Eighth United States Census contains the first authentic statement of production of coal in Georgia. This report, which is for 1860, gives the production in that year as 1,900 short tons. The census for 1870 does not mention any production in Georgia for that year. The Tenth Census (1880) reports an output of coal for the State of 154,644 short tons, since which time the production has been reported in the annual report, Mineral Resources of the United States. The annual production since 1860 is shown in the following table:

Annual production of coal in Georgia, 1860–1909, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1860	1,900	1873	40,000	1886	223,000	1899	233,111
1861	2,500	1874	60,000	1887	313,715	1900	315,557
1862	3,500	1875	80,000	1888	180,000	1901	342,825
1863	6,000	1876	110,000	1889	225,934	1902	414,083
1864	10,000	1877	120,000	1890	228,337	1903	416,951
1865	10,000	1878	128,000	1891	171,000	1904	383,191
1866	8,000	1879	140,000	1892	215,498	1905	351,991
1867	8,000	1880	154,644	1893	372,740	1906	332,107
1868	10,000	1881	168,000	1894	354,111	1907	362,401
1869	12,000	1882	160,000	1895	260,998	1908	264,822
1870	15,000	1883	155,000	1896	238,546	1909	211,196
1871	20,000	1884	150,000	1897	195,869		
1872	25,000	1885	150,000	1898	244,187	Total.	8,599,714

IDAHO.

Total production in 1909, 4,553 short tons; spot value, $19,459.

Several rather small and widely separated areas in Idaho contain subbituminous coal or lignite, from which small quantities are mined annually for local consumption. The production in 1909 amounted to 4,553 short tons, valued at $19,459, a decrease, as compared with 1908, of 876 tons in quantity and of $2,373 in value. All of the output in 1909 was from Fremont and Lemhi counties. A small production was reported in Bingham County in 1908, but none in 1909.

The production of coal in Idaho during the last five years is shown in the following table:

Coal production of Idaho, 1905-1909, in short tons.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
1905	5,782	$16,346	1908	5,429	$21,832
1906	5,365	18,538	1909	4,553	19,459
1907	6,508	26,494			

ILLINOIS.

Total production in 1909, 50,904,990 short tons; spot value, $53,522,014.

As the effects of the business depression in 1908 were felt less seriously in Illinois than in some of the other States and as coal production was fairly well maintained, so in 1909 the recovery was not marked by so large an increase in tonnage as was shown in Pennsylvania and West Virginia, nor by so large a percentage of increase as was made in Alabama, Indiana, and some of the less important States. According to Mr. David Ross, secretary of the bureau of labor statistics of Illinois, whose report covers the fiscal year ended June 30, the production for the fiscal year 1909 was 49,163,710 short tons, a decrease of 108,742 short tons from the fiscal year 1908, and a gain of 1,504,020 short tons as compared with the calendar year 1908, as reported to the Geological Survey. The output for the calendar year 1909 amounted to 50,904,990 short tons, valued at $53,522,014, against 47,659,690 short tons, valued at $49,978,247 in 1908, an increase of 3,245,300 short tons, or 6.8 per cent, in quantity and of $3,543,767, or 7 per cent, in value. Compared with the fiscal year 1909, as reported by Mr. Ross, the production for the calendar year showed an increase of 1,741,280 short tons. The average price per ton in 1909 was $1.05, the change from 1908 being only a fraction of a cent. In 1907 the average price was $1.07 per ton.

Except in one year, 1906, when the biennial suspension pending the adjustment of the wage scale was unusually prolonged, Illinois until 1909 held second place among the coal-producing States since 1883, when it supplanted Ohio. In 1906 West Virginia, whose miners are largely unorganized and were not (except in the Kanawha district) affected by the order of suspension, exceeded Illinois and took second place, falling back to third place in 1907. But although Illinois regained second place in 1907 and held it in 1908, West Virginia again took the lead in 1909.

The coal miners of Illinois are probably better organized than those of any other bituminous coal-mining State. One result of this has been the establishment throughout the coal-mining regions of the eight-hour day. But the biyearly shutdown has naturally resulted in long periods of idleness and loss of income both to operators and to employees. In 1906 practically all of the important mines were shut down and 49,792 men out of a total of 61,988 were idle for an average of fifty-eight days each. This was equivalent to an average of forty-eight days of idleness for each of the 61,988 employees, and was equal to 25 per cent of the total time made. In 1908 the suspension was not of such long duration nor were quite as many men affected, 47,456 men out of a total of 68,035 being idle for an average of thirty-seven days, equivalent to an average idleness of twenty-six days for each of the 68,035 employees and equal to 14 per cent of the total number of days worked by each man during the year. These figures do not mean an actual loss of 25 per cent and 14 per cent, respectively, in wages during the year, for there is a greater intensity of labor both previous and subsequent to the suspension, and the miners, particularly those who work by contract and are paid by the ton, are able to make up a good part of the lost time. This is shown by the fact that notwithstanding the suspension in 1906, which apparently lost 25 per cent in working time, the production increased 3,000,000 tons, or about 8 per cent over 1905. In 1908, however, when the suspension was shorter and when fewer men were involved, the production decreased 3,657,456 tons, or 7.13 per cent, and this decrease was in sympathy with the business depression of that year. It is impossible to say what ''might have been'' in production or in total working time if the suspensions had not occurred, but the unsettling of business and the loss of trade that result from the periodic shutdowns is unwise, and it may well be asked if some better method of dealing with the wage controversy may not be evolved.

The struggle in Illinois over the wage scale for 1910 was unprecedented in its duration and in the feeling engendered, not only between the operators and the miners but between factions of the miners' union, or rather between the Illinois districts and the national organization. With the merits of the case this report has nothing to do, but it may be well to call attention to its effect upon the stability of the industry in the State and upon the working time of the miners. The United States Geological Survey does not collect the statistics of wages nor the cost of coal production, and the only basis of comment are the statistics of production and of the time lost by the miners by reason of the suspension. It will take Illinois some time to recover from the effects of the five months' idleness of 1910.

There was an ample supply of labor for the business done in 1909, taking the State as a whole, but, as stated by Mr. C. L. Scroggs, secretary of the Illinois coal operators' association, in a letter to the writer, there is a constant shortage of labor at individual mines, owing to the fact that the number and capacity of miners in the State is inadequate for the requirements of the trade. This produces a competition to secure miners among the operators, and at the same time, under normal conditions, results in overproduction and cut-throat competition in the efforts to market the product.

According to the report of Mr. David Ross, the year 1909 was for its casualty record the worst in the history of the State, and as Mr. Ross's report covers the fiscal instead of the calendar year, the accident statistics do not include the fire at the Cherry mine, which occurred on November 13 and resulted in the death of nearly 400 men. In the fiscal year ended June 30, 1909, the total number of accidents in the coal mines of Illinois was 1,107, of which 213 were fatal and 894 nonfatal. The largest number of fatalities in any previous year was in 1905, when 199 lives were lost. The production of coal in the fiscal year, according to Mr. Ross, was 49,163,710 short tons, and the number of men employed was 72,733. The death rate per thousand was accordingly 2.94, and there were 230,815 tons of coal mined for each life lost. In 1908 there were 183 fatal accidents; the death rate per thousand was 2.58; and the number of tons mined for each life lost was 269,248. The Cherry disaster cost nearly twice as many lives as were lost in the fiscal year 1909, and more than double the fatal accidents in 1908.

The State bureau of labor statistics has maintained excellent records of the coal-mine accidents for over a quarter of a century. During the twenty-five years ended June 30, 1909, the deaths numbered 2,493 and the injuries 11,569. The prolific cause of accidents, fall of roof and coal, was responsible for more than half of each, 1,310 deaths and 6,438 injuries being attributed to such accidents. That the mines of Illinois have been exceptionally free from gas and dust explosions is shown by the fact that in the twenty-five years the total deaths from this cause have been 153, with 191 injured. Powder explosions and windy shots killed 298 and injured 541, and 732 deaths and 4,399 injuries were due to miscellaneous causes. Twenty-six per cent of the deaths due to explosions in the twenty-five years occurred in 1909; when 40 men were killed in such accidents, 24 of them in an explosion at Zeigler on January 10. Of the other deaths in 1909, 84 were due to falls of roof and coal, 29 to powder explosions and windy shots, and 60 to other causes. In 1909, of the 213 men killed 125 were married; 298 children were left fatherless.

The reports to the Geological Survey and the Bureau of the Census show that in 1909 there were 1,260 mining machines in use in the coal mines of Illinois, and of the 50,904,990 short tons produced, 17,488,427 tons, or 34 per cent, were machine mined. The machines in use included 845 of the pick or puncher type, 405 chain machines, and 10 long-wall.

The introduction of washing machines for improving the quality of the product has made considerable progress in Illinois, and in 1909, 4,064,085 short tons were washed before shipment, the cleaned coal from the washeries amounting to 3,466,097 short tons, and the refuse to 597,988 tons. In 1908, 3,768,112 tons were washed, yielding 3,202,264 tons of cleaned coal.

The statistics of production, by counties, in 1908 and 1909, with the distribution of the product for consumption, are shown in the following table:

Coal production of Illinois in 1908 and 1909, by counties, in short tons.

1908.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Bureau	1,395,610	44,080	73,281	....	1,512,971	$2,205,827	$1.46	175	3,920
Christian	1,214,217	94,510	68,439	....	1,377,166	1,473,887	1.07	177	1,892
Clinton	1,009,470	21,503	47,875	....	1,078,848	985,296	.91	173	1,308
Franklin	2,102,026	28,332	57,025	....	2,187,383	2,231,145	1.02	219	2,191
Fulton	1,906,863	58,524	47,028	....	2,012,415	2,280,334	1.13	184	3,104
Gallatin	42,700	12,498	1,510	2,959	59,667	59,879	1.00	153	121
Grundy	1,008,324	46,452	26,666	....	1,081,442	1,603,153	1.48	230	2,614
Henry	67,810	71,487	2,327	....	141,624	241,653	1.71	205	295
Jackson	527,002	39,682	57,371	....	624,055	776,652	1.24	133	1,270
Knox	....	40,244	796	....	41,040	66,317	1.62	180	90
Lasalle	1,197,642	293,527	66,004	....	1,557,173	2,418,093	1.55	218	3,786
Livingston	204,554	53,218	7,894	....	265,666	382,808	1.44	196	415
Logan	288,190	65,206	19,584	....	372,980	408,836	1.10	154	725
McDonough	736	16,222	860	....	17,818	33,444	1.88	109	82
Macoupin	3,696,056	62,284	135,859	....	3,894,199	3,816,353	.98	177	4,524
Madison	3,175,734	109,383	82,703	....	3,367,820	3,037,941	.90	168	4,087
Marion	905,086	34,552	41,646	....	981,284	898,555	.92	207	1,275
Marshall	349,188	27,638	16,455	....	393,281	620,989	1.58	219	984
Menard	311,133	34,010	10,166	....	355,309	364,663	1.03	174	637
Mercer	337,041	26,416	12,978	....	376,435	505,925	1.34	228	577
Montgomery	1,334,297	40,376	36,305	....	1,410,978	1,341,693	.95	169	1,757
Peoria	772,906	126,934	22,089	....	921,929	1,076,429	1.17	191	1,283
Perry	1,482,791	46,413	47,687	....	1,576,891	1,485,805	.94	153	2,261
Randolph	687,016	47,940	16,649	....	751,605	685,369	.91	173	1,047
Rock Island	16,700	33,512	569	....	50,781	75,069	1.48	179	81
St. Clair	3,415,123	171,596	109,298	....	3,696,017	3,290,064	.89	157	4,671
Saline	2,469,489	33,511	49,137	....	2,552,137	2,400,494	.94	175	3,638
Sangamon	4,605,905	260,299	149,404	....	5,015,608	4,806,946	.96	187	6,371
Scott	....	3,427	....	....	3,427	6,655	1.94	192	14
Shelby	139,186	32,989	9,198	....	181,373	211,759	1.17	155	369
Stark	2,580	17,171	600	....	20,351	35,553	1.75	170	54
Tazewell	133,386	68,954	4,542	....	206,882	236,044	1.14	179	408
Vermilion	2,256,003	155,508	40,974	....	2,452,485	2,445,071	.99	204	3,243
Will	148,007	9,772	4,460	....	162,239	257,764	1.59	178	537
Williamson	5,423,609	73,508	173,357	....	5,670,474	5,313,399	.94	187	6,162
Other counties[a] and small mines	841,865	395,294	50,778	....	1,287,937	1,895,383	1.47	214	2,242
Total	43,468,245	2,696,972	1,491,514	2,959	47,659,690	49,978,247	1.05	185	68,035

1909.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Bureau	1,466,060	83,735	62,657	....	1,612,452	$2,667,714	$1.65	....	....
Christian	1,240,629	91,922	62,607	....	1,395,158	1,361,080	.98	....	....
Clinton	922,330	14,667	33,712	....	970,709	840,955	.87	....	....
Franklin	2,232,716	22,898	60,895	....	2,316,509	2,344,708	1.01	....	....
Fulton	2,242,852	91,199	54,566	....	2,388,617	2,687,916	1.12	....	....
Gallatin	47,338	14,702	2,044	629	64,713	66,780	1.03	....	....
Grundy	1,038,663	46,029	29,409	....	1,114,101	1,805,698	1.62	....	....
Henry	62,510	69,342	5,208	....	137,060	213,299	1.56	....	....
Jackson	576,350	41,150	34,780	....	652,280	787,867	1.21	....	....
Knox	30	20,900	1,043	....	21,973	37,865	1.72	....	....
Lasalle	1,299,706	314,937	71,748	....	1,686,391	2,709,920	1.61	....	....
Livingston	183,035	54,952	8,044	....	246,031	355,159	1.44	....	....
Logan	315,505	49,661	30,722	....	395,888	420,949	1.06	....	....
McDonough	1,640	14,636	....	....	16,276	32,599	2.00	....	....
Macon	78,441	149,288	10,878	....	238,607	379,278	1.59	....	....

[a] Bond, Calhoun, Edgar, Greene, Hamilton, Hancock, Jefferson, Jersey, Kankakee, McLean, Macon, Morgan, Moultrie, Putnam, Schuyler, Warren, Washington, White, and Woodford.

Coal production of Illinois in 1908 and 1909, by counties, in short tons—Continued.

1909—Continued.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Macoupin	4,435,247	55,796	106,732	....	4,597,775	$4,262,484	$0.93	....	....
Madison	3,208,365	81,999	83,434	....	3,373,798	3,018,927	.89	....	....
Marion	1,088,738	36,863	46,349	....	1,171,950	1,040,326	.89	....	....
Marshall	254,367	32,997	8,448	....	295,812	465,303	1.57	....	....
Menard	262,739	33,596	7,613	....	303,948	331,420	1.09	....	....
Mercer	326,740	29,985	13,037	....	369,762	494,778	1.34	....	....
Montgomery	1,698,360	38,204	44,104	....	1,780,668	1,750,978	.98	....	....
Peoria	768,096	123,837	23,028	....	914,961	1.080,478	1.18	....	....
Perry	1,351,240	25,609	46,286	....	1,423,135	1,247,952	.87	....	....
Randolph	762,873	22,797	14,223	....	799,893	732,147	.92	....	....
Rock Island	13,535	30,525	2,168	....	46,228	67,792	1.47	....	....
St. Clair	3,196,913	183,083	91,634	....	3,471,630	3,028,452	.87	....	....
Saline	3,196,902	31,200	55,837	....	3,283,939	3,072,287	.94	....	....
Sangamon	5,158,239	314,540	143,578	....	5,616,357	5,416,284	.96	....	....
Scott	....	1,756	300	....	2,056	5,162	2.50	....	....
Shelby	93,818	24,661	5,608	....	124.087	168,605	1.36	....	....
Stark	6,016	16,334	809	....	23,159	38,715	1.67	....	....
Tazewell	121,277	80,577	6,195	....	208,049	257,520	1.24	....	....
Vermilion	1,628,841	236,132	54,982	....	1,919,955	1,899,735	.99	....	....
Warren	....	11,440	864	....	12,304	25,683	2.09	....	....
Will	146,294	11,918	4,095	....	162,307	254,530	1.57	....	....
Williamson	6,271,779	73,062	192,813	....	6,537,654	6,354,491	.99	....	....
Other counties[a] and small mines	897,101	262,018	49,679	....	1,208,798	1,796,178	1.49	....	....
Total	46,595,285	2,838,947	1,470,129	629	50,904,990	53,522,014	1.05	....	69,425

[a] Bond, Crawford, Greene, Hancock, Jefferson, Jersey, Kankakee, McLean, Morgan, Moultrie, Putnam, Schuyler, Washington, White, and Woodford.

Illinois contains more coal-producing counties than any other State in the Union, there having been in 1909 52 counties that produced more than 1,000 tons each. Among these Williamson County is well in the lead with an output of 6,537,654 short tons in 1909. Williamson County also showed the largest increase (867,180 short tons) over 1908. Sangamon County ranks second with a record in 1909 of 5,616,357 short tons; increase over 1908, 600,749 tons. Macoupin, the third county in rank, increased 703,576 short tons, from 3,894,199 tons in 1908 to 4,597,775 tons in 1909. Probably the most significant increase, as indicating the region of most active new development, was in Saline County, which increased 731,802 short tons, or nearly 30 per cent, from 2,552,137 short tons in 1908 to 3,283,939 tons in 1909. The increase in Saline County's production in 1909 was more than its total output in any one year prior to 1906. Other important increases in 1909 were in Fulton County, 376,202 tons, and Montgomery County, 369,690 tons. The largest decrease in 1909 was exhibited in the production of Vermilion County, which declined from 2,452,485 tons to 1,919,955 tons, a loss of 532,530 tons.

In the following table are shown the statistics of production of coal in Illinois, by counties, during the last five years, with increase and decrease in 1908 as compared with 1907:

Coal production of Illinois, 1905–1909, by counties, in short tons.

County.	1905.	1906.	1907.	1908.	1909.	Increase (+) or decrease (−), 1909.
Bond	126,231	132,325	138,990	60,129	89,861	+ 29,732
Bureau	1,701,255	1,580,085	2,010,762	1,512,971	1,612,452	+ 99,481
Calhoun	4,727	5,045	2,850	3,521	....	− 3,521
Christian	879,360	934,452	1,368,159	1,377,166	1,395,158	+ 17,992
Clinton	579,281	515,796	1,302,391	1,078,848	970,709	− 108,139
Franklin	....	....	1,306,966	2,187,383	2,316,509	+ 129,126
Fulton	1,529,249	1,579,224	2,113,643	2,012,415	2,388,617	+ 376,202
Gallatin	82,682	92,731	78,055	59,667	64,713	+ 5,046
Greene	4,435	2,206	2,310	9,506	7,318	− 2,188
Grundy	1,310,892	1,162,019	1,327,321	1,081,442	1,114,101	+ 32,659
Hamilton	....	....	....	(c)	....	....
Hancock	3,300	4,498	2,034	1,406	1,085	− 321
Henry	146,995	149,188	149,721	141,624	137,060	− 4,564
Jackson	818,841	646,196	645,333	624,055	652,280	+ 28,225
Jefferson	25,925	7,600	12,000	18,675	4,800	− 13,875
Jersey	....	1,397	1,162	1,496	1,000	− 496
Kankakee	700	39,499	26,704	30,994	25,000	− 5,994
Knox	58,972	51,654	40,996	41,040	21,973	− 19,067
Lasalle	1,772,988	1,467,672	1,677,990	1,557,173	1,686,391	+ 129,218
Livingston	284,984	273,831	303,497	265,666	246,031	− 19,635
Logan	445,546	435,559	477,115	372,980	395,888	+ 22,908
McDonough	19,496	43,774	32,199	17,818	16,276	− 1,542
McLean	159,921	145,000	151,146	95,854	116,412	+ 20,558
Macon	231,235	292,884	269,766	235,237	238,607	+ 3,370
Macoupin	3,177,484	3,637,827	4,507,270	3,894,199	4,597,775	+ 703,576
Madison	3,434,399	3,324,857	3,927,721	3,367,820	3,373,798	+ 5,978
Marion	1,009,759	1,042,866	1,185,533	981,284	1,171,950	+ 190,666
Marshall	499,672	418,904	482,796	393,281	295,812	− 97,469
Menard	415,266	429,971	389,918	355,309	303,948	− 51,361
Mercer	532,854	412,165	453,621	376,435	369,762	− 6,673
Montgomery	598,064	720,415	1,289,021	1,410,978	1,780,668	+ 369,690
Morgan	4,565	9,100	5,513	3,244	1,200	− 2,044
Peoria	897,946	914,863	1,103,312	921,929	914,961	− 6,968
Perry	1,298,572	1,509,716	1,784,469	1,576,891	1,423,135	− 153,756
Putnam	....	156,928	362,858	466,019	597,703	+ 131,684
Randolph	440,991	634,270	824,761	751,605	799,893	+ 48,288
Rock Island	68,383	62,321	52,938	50,781	46,228	− 4,553
St Clair	3,329,914	4,904,811	4,511,879	3,696,017	3,471,630	− 224,387
Saline	675,701	980,864	2,247,842	2,552,137	3,283,939	+ 731,802
Sangamon	4,324,263	4,543,849	5,160,042	5,015,608	5,616,357	+ 600,749
Schuyler	2,880	3,090	7,553	15,269	4,573	− 10,696
Scott	13,423	12,437	17,639	3,427	2,056	− 1,371
Shelby	104,216	138,257	155,930	181,373	124,087	− 57,286
Stark	22,725	17,661	25,897	20,351	23,159	+ 2,808
Tazewell	231,373	189,882	235,971	206,882	208,049	+ 1,167
Vermilion	2,342,238	2,389,285	2,973,253	2,452,485	1,919,955	− 532,530
Warren	10,354	9,520	9,139	11,687	12,304	+ 617
Washington	87,913	85,812	29,000	72,500	31,322	− 41,178
White	....	8,000	16,453	19,583	22,133	+ 2,550
Will	137,957	154,955	183,985	162,239	162,307	+ 68
Williamson	4,167,952	4,417,987	5,697,944	5,670,474	6,537,654	+ 867,180
Woodford	a 348,707	a 717,566	b 158,742	d 174,031	194,410	+ 20,379
Small mines	69,777	69,299	75,036	68,786	e 111,981	+ 43,195
Total	38,434,363	41,480,104	51,317,146	47,659,690	50,904,990	+3,245,300
Total value	$40,577,592	$44,763,062	$54,687,382	$49,978,247	$53,522,014	+$3,543,767

[a] Includes production of Franklin County.
[b] Includes production of Wabash County.
[c] Included with production of Hancock County.
[d] Includes production of Edgar and Moultrie counties.
[e] Includes production of Crawford and Moultrie counties.

Probably the earliest mention of coal in the United States is contained in the journal of Father Hennepin, a French missionary, who as early as 1679 reported a "cole" mine on Illinois River above Fort Crevecoeur, near the site of the present city of Ottawa. Father Hennepin marked the location of the occurrence on the map which illustrates his journal. It is also probable that, outside of anthracite mining in Pennsylvania and the operations of the Richmond Basin in Virginia, Illinois holds the record for priority of production. The earliest statement that we have in regard to actual mining in Illinois is that coal was produced in Jackson County in 1810 from a point on Big Muddy River. A flatboat was loaded with coal at this place and shipped to New Orleans, but the quantity is not stated. Again, it is reported that in 1832 several boat loads were sent from the same vicinity to the same market. Another record is found stating that 150,000 bushels (or 6,000 tons) of coal were mined in 1833 in St. Clair County and hauled by wagons to St. St. Louis. From 1840 to 1860 the bureau of statistics of the State is without any reliable data in regard to the coal-mining industry, although some scattering statistics are found in the geologic reports published by the State government. The production of coal in Illinois from 1833 to the close of 1909 is shown in the following table:

Production of coal in Illinois, 1833 to 1909, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1833	6,000	1853	375,000	1873	3,920,000	1893	19,949,564
1834	7,500	1854	385,000	1874	4,203,000	1894	17,113,576
1835	8,000	1855	400,000	1875	4,453,178	1895	17,735,864
1836	10,000	1856	410,000	1876	5,000,000	1896	19,786,626
1837	12,500	1857	450,000	1877	5,350,000	1897	20,072,758
1838	14,000	1858	490,000	1878	5,700,000	1898	18,599,299
1839	15,038	1859	530,000	1879	5,000,000	1899	24,439,019
1840	16,967	1860	728,400	1880	6,115,377	1900	25.767,981
1841	35,000	1861	670,000	1881	6,720,000	1901	27,331,552
1842	58,000	1862	780,000	1882	9,115,653	1902	32,939,373
1843	75,000	1863	890,000	1883	12,123,456	1903	36,957,104
1844	120,000	1864	1,000,000	1884	12,208,075	1904	36,475,060
1845	150,000	1865	1,260,000	1885	11,834,459	1905	38,434,363
1846	165,000	1866	1,580,000	1886	11,175,241	1906	41,480,104
1847	180,000	1867	1,800,000	1887	12,423,066	1907	51,317,146
1848	200,000	1868	2,000,000	1888	14,328,181	1908	47,659,690
1849	260,000	1869	1,854,000	1889	12,104,272	1909	50,904,990
1850	300,000	1870	2,624,163	1890	15,292,420		
1851	320,000	1871	3,000,000	1891	15,660,698	Total	744,432,989
1852	340,000	1872	3,360,000	1892	17,862,276		

INDIANA.

Total production in 1909, 14,834,259 short tons; spot value, $15,154,681.

A new record in production was made by the coal mines of Indiana in 1909, the previous maximum output in 1907 being exceeded by nearly 850,000 short tons. From 13,985,713 short tons in 1907, the production fell off in 1908 to 12,314,890 short tons; the decrease in the latter year was due in part to the business depression and in part to the biennial adjustment of the wage scale, most of the mines being shut down for two months in the spring before an agreement was reached. The recovery in 1909 amounted to an increase of 2,519,369 short tons, or 20.4 per cent, to 14,834,259 tons; and the value increased from $13,084,297 in 1908 to $15,154,681, a gain of $2,070,384, or 15.8 per cent. The average price per ton was $1.02 in 1909 against $1.06 in 1908, the lower price in 1909 being due rather to the larger sales of lower-grade coals than to a general decline in values. With a brisk demand operators are able to dispose of a larger proportion of slack coal than when the demand is poor and consumers are more exacting in their requirements. This is particularly true in such States as Indiana, whose coal does not possess high coking quality and where the slack, if sold at all, must be sold at much below the price of screened coal and sometimes even below the cost of production.

Of the 19 counties in Indiana which in 1909 produced coal, 16 showed increased production over 1908, and in 3 the production decreased. The decrease was small, the aggregate for the 3 counties being 18,303 tons. Vigo County, the leading coal-producing county, was credited with the largest increase in 1909, showing a gain of 827,135 tons, from 2,735,399 tons in 1908 to 3,562,534 tons in 1909. Sullivan County, second in rank, increased its output 624,972 tons. Other important increases were in Vermilion County, 300,297 tons; Greene County, 251,282 tons; Knox, 213,906 tons, and Clay, 95,083 tons. Owen County appears for the first time as a coal-producing county, with an output of nearly 16,000 tons.

Almost exactly 50 per cent of Indiana's coal production in 1909 was won by the use of machines, the machine-mined product amounting to 7,408,829 short tons out of a total of 14,834,259 tons; in 1908 the machine-mined coal amounted to 5,294,092 short tons, or 43 per cent of the total. Machines of the chain-breast pattern appear to be the preferred type in the mines of Indiana, 391 out of a total of 631 in use in 1909 being chain machines. Of the other 240 machines, 227 were pick and 13 were long-wall. In 1908 out of a total of 507 machines in use, 332 were chain machines, 140 were pick machines, and 35 were long-wall. If the statistics of machine mining may be taken as evidence, the long-wall method of mining is not popular in Indiana. In 1907 there were 58 long-wall machines in use; in 1908 the number had decreased to 35; and in 1909 only 13 of this type were employed.

There were only two cases of labor trouble reported in the coal mines of Indiana in 1909, neither of sufficient importance to affect the production.

In 1909 a small quantity of coke was made in Indiana from Indiana coal, the first coal of the State so used in several years.

According to Mr. James Epperson, state mine inspector, the number of men killed in the coal mines of Indiana during 1909 was 50, an increase of 5 from 1908. There were 1,079 men injured, 8 of the accidents resulting in permanent disability; 525 more injuries were of a serious character and 546 were minor injuries. Of the 50 men killed, 25 met death by falls of rock or coal in rooms and gangways, and 331 others were injured from the same cause; 4 deaths and 381 injuries were caused by mine cars; 3 men were killed and 25 injured by windy shots and powder explosions; shaft accidents killed 3 and injured 9; gas and dust explosions killed 7 and injured 32; and 8 deaths and 301 injuries were attributed to miscellaneous causes.

Mr. Epperson also reports that during 1909 there were 18,908 men employed in the coal mines of Indiana. The production reported to the Geological Survey and the Bureau of the Census amounted to 14,834,259 short tons, according to which there were 296,685 tons mined for each life lost, and the death rate per thousand men employed was 2.64, against 273,664 tons mined for each fatality, and a death rate of 2.45 per thousand, in 1908.

In the period of sixteen years for which the causes of the accidents in the coal mines of Indiana have been reported, 651 men were killed and 4,235 injured. The mines of this State have been singularly free from serious explosions, for in the sixteen years only 28 deaths have been due to this cause—and 7 of these occurred in 1909; nearly half of the fatalities (212) and one-third of the injuries (1,477) were due to falls of roof or coal; 49 deaths and 151 injuries were due to powder explosions and windy shots; and 164 deaths and 2,311 injuries were attributed to other causes.

The statistics of coal production in Indiana in 1908 and 1909, by counties, with the distribution of the product for consumption, are shown in the following table:

Coal production of Indiana in 1908 and 1909, by counties, in short tons.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
1908.									
Clay	779,879	49,649	31,121	....	863,649	$1,155,967	$1.34	189	1,704
Daviess	44,930	29,889	2,215	....	77,034	107,734	1.40	142	213
Dubois and Martin	....	12,020	300	....	12,320	15,275	1.24	169	18
Fountain and Warren	....	4,600	200	....	4,800	9,147	1.91	240	22
Gibson	166,143	18,227	4,130	....	188,500	191,179	1.01	237	233
Greene	2,274,070	31,529	55,805	....	2,361,404	2,460,227	1.04	163	2,830
Knox	395,737	18,542	14,542	....	428,821	420,959	.98	184	561
Parke	599,788	19,024	25,250	....	644,062	870,819	1.35	188	1,151
Perry	2,000	8,451	150	....	10,601	16,692	1.57	137	46
Pike	418,223	32,808	9,149	....	460,180	474,827	1.03	179	957
Spencer	4,000	9,186	20	....	13,206	19,440	1.47	141	47
Sullivan	2,521,793	26,625	54,125	....	2,602,543	2,647,827	1.02	159	3,694
Vanderburg	59,900	193,677	9,594	....	263,171	315,408	1.20	216	453
Vermilion	1,087,048	18,464	37,290	....	1,142,802	1,070,204	.94	158	1,860
Vigo	2,590,226	77,015	68,158	....	2,735,399	2,807,199	1.03	191	3,807
Warrick	427,451	36,919	18,243	....	482,613	469,301	.97	150	784
Small mines	....	23,785	....	....	23,785	32,092	1.35	....	....
Total	11,371,188	610,410	333,292	....	12,314,890	13,084,297	1.06	174	18,380
1909.									
Clay	870,679	54,538	33,515	....	958,732	$1,251,035	$1.31	....	....
Daviess	36,861	33,929	3,087	....	73,877	103,380	1.40	....	....
Dubois and Martin	8,540	25,978	886	....	35,404	48,147	1.36	....	....
Fountain and Warren	....	12,290	360	....	12,650	20,144	1.59	....	....
Gibson	197,572	29,979	5,048	....	232,599	234,852	1.01	....	....
Greene	2,477,607	56,577	76,002	2,500	2,612,686	2,645,948	1.01	....	....
Knox	604,987	24,555	13,185	....	642,727	628,887	.98	....	....
Owen	9,081	6,588	235	....	15,904	20,936	1.32	....	....
Parke	671,303	31,886	26,893	....	730,082	911,377	1.25	....	....
Perry	200	15,245	158	....	15,603	21,566	1.38	....	....
Pike	403,944	33,918	9,260	....	447,122	458,525	1.03	....	....
Spencer	1,822	9,160	136	....	11,118	14,270	1.28	....	....
Sullivan	3,022,344	73,861	131,310	....	3,227,515	3,108,337	.96	....	....
Vanderburg	39,368	224,410	7,866	....	271,644	347,733	1.28	....	....
Vermilion	1,411,887	9,989	21,223	....	1,443,099	1,353,221	.94	....	....
Vigo	3,337,442	129,756	95,336	....	3,562,534	3,442,191	.97	....	....
Warrick	440,951	36,387	10,856	....	488,194	470,711	.96	....	....
Small mines	....	52,769	....	....	52,769	73,421	1.39	....	....
Total	13,534,588	861,815	435,356	2,500	14,834,259	15,154,681	1.02	....	20,937

In the following table is shown the production of coal in Indiana, by counties, during the last five years, with increase and decrease in 1909 as compared with 1908:

Coal production of Indiana, 1905–1909, by counties, in short tons.

County.	1905.	1906.	1907.	1908.	1909.	Increase (+) or decrease (−) 1909.
Clay	781,574	1,101,228	1,266,507	863,649	958,732	+ 95,083
Daviess	101,429	135,985	120,996	77,034	73,877	− 3,157
Dubois	a 7,200	a 14,700	a 8,460	a 12,320	a 35,404	+ 23,084
Fountain	b 79,995	b 84,469	b 41,270	....	5,520	+ 5,520
Gibson	99,322	142,444	207,472	188,500	232,599	+ 44,099
Greene	2,458,665	2,307,486	2,773,944	2,361,404	2,612,686	+ 251,282
Knox	293,480	333,833	374,099	428,821	642,727	+ 213,906
Owen	....	....	....	....	15,904	+ 15,904
Parke	750,314	707,027	655,312	644,062	730,082	+ 86,020
Perry	17,018	13,261	17,965	10,601	15,603	+ 5,002
Pike	452,396	497,957	516,418	460,180	447,122	− 13,058
Spencer	16,935	19,256	25,916	13,206	11,118	− 2,088
Sullivan	2,571,818	2,415,847	2,897,840	2,602,543	3,227,515	+ 624,972
Vanderburg	300,112	302,919	317,371	263,171	271,644	+ 8,473
Vermilion	1,302,667	1,342,478	1,442,103	1,142,802	1,443,099	+ 300,297
Vigo	2,189,603	2,197,459	2,724,743	2,735,399	3,562,534	+ 827,135
Warren	....	....	....	4,800	7,130	+ 4,800
Warrick	447,576	447,995	568,522	482,613	488,194	+ 5,581
Small mines	25,148	28,216	26,775	23,785	52,769	+ 28,984
Total	11,895,252	12,092,560	13,985,713	12,314,890	14,834,259	+ 2,519,369
Total value	$12,492,255	$13,116,261	$15,114,300	$13,084,297	$15,154,681	+$2,070,384

a Includes Martin County. b Includes Warren County.

The United States census for 1840 reports a production of coal in Indiana for that year which amounted to 9,682 tons. The census for 1850 did not include any investigation of the mining industry, and the next official statistics are for the year 1860, when the census reported a production of 101,280 short tons. Ten years later the census of 1870 reported a production of 437,870 short tons. In 1880 the production had grown to 1,454,327 short tons, and in 1890 it amounted to 3,305,737 short tons. In the closing year of the last century the production had nearly doubled again, amounting to 6,484,086 short tons, and this output was more than doubled again by the tonnage of 1909.

The statistics of coal production in Indiana from 1840 up to the close of 1909 are given in the following table, the years for which no official statistics are available having been estimated from the best information obtainable:

Production of coal in Indiana from 1840 to 1909, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1840	9,682	1858	87,000	1876	950,000	1894	3,423,921
1841	10,000	1859	95,000	1877	1,000,000	1895	3,995,892
1842	18,000	1860	101,280	1878	1,000,000	1896	3,905,779
1843	25,000	1861	128,000	1879	1,196,490	1897	4,151,169
1844	30,000	1862	150,000	1880	1,454,327	1898	4,920,743
1845	35,000	1863	200,000	1881	1,984,120	1899	6,006,523
1846	40,000	1864	250,000	1882	1,976,470	1900	6,484,086
1847	45,000	1865	280,000	1883	2,560,000	1901	6,918,225
1848	50,000	1866	320,000	1884	2,260,000	1902	9,446,424
1849	56,000	1867	350,000	1885	2,375,000	1903	10,794,692
1850	60,000	1868	375,000	1886	3,000,000	1904	10,842,189
1851	60,000	1869	400,000	1887	3,217,711	1905	11,895,252
1852	75,000	1870	437,870	1888	3,140,979	1906	12,092,560
1853	75,000	1871	600,000	1889	2,845,057	1907	13,985,713
1854	80,000	1872	896,000	1890	3,305,737	1908	12,314,890
1855	80,000	1873	1,000,000	1891	2,973,474	1909	14,834,259
1856	85,000	1874	812,000	1892	3,345,174		
1857	85 000	1875	800,000	1893	3,791,851	Total	186,589,539

IOWA.

The total production in 1909, 7,757,762 short tons; spot value, $12,793,628.

The year 1909 was to the coal-mining industry of the State the most prosperous in its history. Not only was the production of 7,757,762 short tons the largest recorded, but the prices reached the highest figures, in which particular Iowa was a notable exception to the general rule in 1909. The average price for the State in 1909 was $1.65 per short ton, against $1.63 in 1908 and $1.62 in 1907. During the last twenty-five years there was only one year, 1903, in which the average price was as high as in 1909, and in no case was it exceeded. The production in 1909 exceeded that of 1908 (7,161,310 short tons) by 596,452 tons, or 8.3 per cent. The value increased from $11,706,402 in 1908 to $12,793,628 in 1909, a gain of $1,087,226, or 9.2 per cent. Compared with the previous high record of 1907, the production in 1909 showed an increase of 183,440 short tons in quantity and of $535,616 in value.

Of the 22 counties in which coal is produced, 16 showed increase in 1909, and in 6 the production in 1909 was less than in 1908. The largest increase, 171,234 short tons, was reported from Polk County. Mahaska County gained 117,923 tons; Appanoose, 91,604 tons; Wapello, 72,014 tons; Dallas County, 69,634 tons; and Monroe County, 58,222 tons. Dallas County has assumed importance as a coal producer in the last three years, rising from 5,522 tons in 1906 to 70,042 tons in 1907, to 174,585 tons in 1908, and to 244,219 tons in 1909, the increase in 1909 over 1908 being nearly as large as the total production of the county in 1907.

There were a few instances of labor disaffection in the coal mines of Iowa, but the troubles were not of a serious character, and the total idleness was not sufficient to affect the production. The longest strike was of thirty-one days, in which 68 men were idle; in another strike 60 men were idle for thirty days; and in another 30 men were out for twenty days. In all, 2,036 men were on strike at one time or another, but most of them for a day or two at a time. The average time lost by the 2,036 men was six days.

Mining machines were reported in use at only one mine in Iowa during 1909, and only 5 machines were operated, a decrease from 28 in 1908. The quantity of coal mined by machines has decreased from nearly 200,000 tons in 1906, to 108,022 tons in 1907, to 71,463 tons in 1908, and to 7,500 tons in 1909.

The casualty record for 1909, as reported by Messrs. John Verner, R. T. Rhys, and Edward Sweeny, inspectors, shows 37 deaths and 103 injuries, against 31 and 90, respectively, in 1908. Falls of roof and coal caused 22 of the fatal accidents and 49 of the injuries in 1909. Only one death was due to gas explosion. The production for the year was 7,757,762 short tons. The number of tons mined for each fatality was 209,669 in 1909 and 231,010 in 1908.

In sixteen years since 1892 (the figures for two years, 1896 and 1897, being missing) 552 men have been killed and 1,018 injured in the coal mines of Iowa. This State, like Indiana, has been remarkably free from explosions of dust and gas, only 11 of the 469 deaths in sixteen years being due to this cause, and 8 of these 11 men were killed in one year, 1893. Falls of roof and coal were the most prolific cause of death, 300 victims being scored against them. More than half of the nonfatal accidents, 567 out of 1,018, were also due to this cause.

The statistics of coal production in Iowa in 1908 and 1909, by counties, with the distribution of the product for consumption, are shown in the following table:

Coal production of Iowa in 1908 and 1909, by counties, in short tons.

1908.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Adams	300	17,152	40	17,492	$42,235	$2.41	140	77
Appanoose	1,085,787	47,301	11,317	1,144,405	2,121,191	1.85	184	3,811
Boone	196,537	32,421	8,540	237,498	458,560	1.93	186	735
Greene		15,031	400	15,431	36,481	2.36	215	44
Guthrie		12,679	5	12,684	35,725	2.82	161	66
Jasper	364,500	10,826	18,190	393,516	600,078	1.52	235	796
Keokuk		17,331	970	18,301	34,044	1.86	222	29
Mahaska	753,051	35,191	19,273	807,515	1,180,174	1.46	216	1,781
Marion	264,538	27,779	2,290	294,607	436,442	1.48	202	636
Monroe	1,865,842	49,115	52,380	1,967,337	2,803,539	1.43	243	3,234
Polk	1,350,556	225,795	40,544	1,616,895	2,808,066	1.74	228	3,117
Taylor	7,806	10,057	140	18,003	41,881	2.33	214	66
Van Buren	7,476	7,841	45	15,362	32,389	2.11	188	44
Wapello	127,871	58,903	2,732	189,506	301,214	1.59	191	440
Wayne	114,074	13,253	82	127,409	237,065	1.86	225	421
Webster	46,937	14,730	1,101	62,768	128,061	2.04	184	187
Other counties [a] and small mines	160,315	55,076	7,190	222,581	409,257	1.84	214	537
Total	6,345,590	650,481	165,239	7,161,310	11,706,402	1.63	214	16,021

1909.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Adams	650	12,297	247	13,194	$33,040	$2.50		
Appanoose	1,154,143	55,030	26,836	1,236,009	2,283,604	1.85		
Boone	234,489	31,767	9,455	275,711	523,272	1.90		
Greene	750	8,950		9,700	24,450	2.52		
Guthrie		6,720	10	6,730	18,785	2.79		
Jasper	299,801	12,337	10,954	323,092	529,868	1.64		
Keokuk	1,200	12,786	444	14,430	28,429	1.97		
Mahaska	857,684	48,660	19,094	925,438	1,416,250	1.53		
Marion	267,251	51,472	10,630	329,353	458,733	1.39		
Monroe	1,918,938	56,681	49,940	2,025,559	2,949,413	1.46		
Page		15,923	211	16,134	48,408	3.00		
Polk	1,505,808	210,539	71,782	1,788,129	3,065,139	1.71		
Taylor	6,126	7,351	59	13,536	32,351	2.39		
Van Buren	10,100	5,699	156	15,955	33,316	2.09		
Wapello	176,943	80,164	4,413	261,520	411,310	1.57		
Warren	280	15,921		16,201	42,527	2.62		
Wayne	114,012	11,717	2,275	128,004	248,790	1.94		
Webster	54,068	11,462	1,054	66,584	130,312	1.96		
Other counties [b] and small mines	234,528	52,939	5,016	292,483	515,631	1.76		
Total	6,836,771	708,415	212,576	7,757,762	12,793,628	1.65		17,286

[a] Dallas, Davis, Jefferson, Lucas, Page, Scott, and Warren.
[b] Dallas, Jefferson, Lucas, and Scott.

The production by counties during the last five years, with increase and decrease in 1909 as compared with 1908, is shown in the following table:

Coal production of Iowa, 1905–1909, by counties, in short tons.

County.	1905.	1906.	1907.	1908.	1909.	Increase(+) or decrease (−), 1909.
Adams	13,071	11,724	14,343	17,492	13,194	− 4,298
Appanoose	884,248	1,101,595	1,123,409	1,144,405	1,236,009	+ 91,604
Boone	292,659	233,110	208,150	237,498	275,711	+ 38,213
Dallas	5,000	5,522	70,042	174,585	244,219	+ 69,634
Davis			1,300	3,700		− 3,700
Greene	20,058	19,816	16,289	15,431	9,700	− 5,731
Jasper	306,164	388,582	397,297	393,516	323,092	− 70,424
Jefferson	3,379	3,744	4,000	3,500	6,255	+ 2,755
Keokuk	16,460	17,144	27,716	18,301	14,430	− 3,871
Lucas	147,093	97,147	105,536	8,739	9,326	+ 587
Mahaska	714,945	602,487	757,778	807,515	925,438	+ 117,923
Marion	338,812	372,750	346,999	294,607	329,353	+ 34,746
Monroe	2,225,677	2,458,473	2,476,021	1,967,337	2,025,559	+ 58,222
Page	14,013	11,235	14,338	11,364	16,134	+ 4,770
Polk	1,210,320	1,369,506	1,460,203	1,616,895	1,788,129	+ 171,234
Scott	6,222	24,778	1,047	1,248	8,400	+ 7,152
Taylor	22,345	19,052	19,692	18,003	13,536	− 4,467
Van Buren	6,192	12,137	15,374	15,362	15,955	+ 593
Wapello	303,360	243,256	258,651	189,506	261,520	+ 72,014
Warren	9,876	2,850	5,054	6,820	16,201	+ 9,381
Wayne	112,549	136,694	146,901	127,409	128,004	+ 595
Webster	113,393	109,522	80,275	62,768	66,584	+ 3,816
Other counties and small mines	32,773	25,100	23,907	25,309	31,013	+ 5,704
Total	6,798,609	7,266,224	7,574,322	7,161,310	7,757,762	+ 596,452
Total value	$10,586,381	$11,619,455	$12,258,012	$11,706,402	$12,793,628	+$1,087,226

Iowa probably ranks second among the States west of Mississippi River in order of priority as a coal producer. At the time of taking the United States census for 1840 Iowa and Missouri were the only States west of the river in which any coal production was reported. Missouri, however, was credited with an output of nearly 10,000 tons, while Iowa's production was given at 400 tons. It is probable, therefore, that the first mine opened in Missouri antedated Iowa's initial production. The production of coal in Iowa since 1840 will be found in the following table, estimates being given for years for which no official figures are available:

Production of coal in Iowa, 1840 to 1909, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1840	400	1858	37,500	1876	1,250,000	1894	3,967,253
1841	500	1859	42,000	1877	1,300,000	1895	4,156,074
1842	750	1860	41,920	1878	1,350,000	1896	3,954,028
1843	1,000	1861	50,000	1879	1,400,000	1897	4,611,865
1844	2,500	1862	53,000	1880	1,461,116	1898	4,618,842
1845	5,000	1863	57,000	1881	1,960,000	1899	5,177,479
1846	6,500	1864	63,000	1882	3,920,000	1900	5,202,939
1847	8,000	1865	69,574	1883	4,457,540	1901	5,617,499
1848	10,000	1866	99,320	1884	4,370,566	1902	5,904,766
1849	12,500	1867	150,000	1885	4,012,575	1903	6,419,811
1850	15,000	1868	241,453	1886	4,315,779	1904	6,519,933
1851	18,000	1869	295,105	1887	4,473,828	1905	6,798,609
1852	20,000	1870	263,487	1888	4,952,440	1906	7,266,224
1853	23,000	1871	300,000	1889	4,095,358	1907	7,574,322
1854	25,000	1872	336,000	1890	4,021,739	1908	7,161,310
1855	28,000	1873	392,000	1891	3,825,495	1909	7,757,762
1856	30,000	1874	799,936	1892	3,918,491		
1857	33,000	1875	1,231,547	1893	3,972,229	Total	156,527,864

KANSAS.

Total production in 1909, 6,986,478 short tons; spot value $10,083,384.

In spite of the increased competition of petroleum and natural gas from the Mid-Continent field, the production of coal in Kansas increased from 6,245,508 short tons in 1908 to 6,986,478 short tons in 1909, a gain of 740,970 tons, or 11.9 per cent. The influence of the competition of oil and gas was shown in the lower price for coal in 1909, the average price showing a decline from $1.49 to $1.44. The total value increased $791,162, or 8.5 per cent, from $9,292,222 in 1908, to $10,083,384 in 1909.

Two counties, Cherokee and Crawford, in the extreme southeastern corner of the State, produce nearly 95 per cent of the State's total, contributing 6,529,959 short tons out of 6,986,478 tons in 1909, and the increase in these two counties in 1909—375,866 tons in Cherokee County and 410,194 tons in Crawford County—aggregated more than the total increase for the State, the production in most of the other counties having decreased. Leavenworth County was credited in 1909 with a production of 321,132 short tons, a decrease of 26,985 tons as compared with 1908. Probably three-fourths of this tonnage should be credited to Platte County, Mo., as the workings at Leavenworth, Kans., extend under Missouri River into the State of Missouri and most of the production comes from the latter State. It has been customary, however, to credit the production to the State and county in which the tipple is located, and all of this tonnage is therefore credited to Leavenworth County, Kans. If the portion mined in Missouri were deducted from the Kansas production, Cherokee and Crawford counties would furnish all but about 2 per cent of the State's total. The larger part of the output of Kansas, and particularly that from Cherokee and Crawford counties, is used for locomotive fuel and some of the larger mines are operated either by the fuel departments of the railroads or by companies affiliated with the transportation interests. In such cases none of the product is marketed as commercial coal. Osage County has a number of mines, but they are comparatively small and the product is sold principally for domestic use.

Labor conditions were generally satisfactory throughout 1909. At the mines of one company the men were idle from January 1 to November 1, on a strike which had begun in 1908. At one other colliery 20 men were idle 95 days. Except in those instances all of the suspensions were because of local grievances and were of short duration, usually for only a day or two at a time. Altogether 4,715 men were idle at one time or another during the year, but the entire idleness was not of sufficient importance to influence the production.

The quantity of coal mined by machinery in Kansas decreased from 133,248 tons in 1908 to 59,976 tons in 1909. The number of machines in use decreased from 17 to 16.

In fifteen of the twenty-five years for which the statistics of accidents in the coal mines of Kansas are available, 383 men have been killed and 637 injured. Less than 9 per cent of the deaths (24 in all) were due to explosions of gas and dust, and of these, 22 have occurred in the last three years. Falls of roof and coal killed 130 and injured 299. During 1909 there were 35 deaths in the Kansas coal mines, an increase of 8 over 1908, and the nonfatal accidents increased from 70 to 91, these figures being reported by Mr. Frank Gilday, state mine inspector.

The statistics of the production of coal in Kansas in 1908 and 1909, with the distribution of the product for consumption, are shown in the following table:

Coal production of Kansas in 1908 and 1909, by counties, in short tons.

1908.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Cherokee	1,765,194	20,852	40,035		1,826,081	$2,707,769	$1.48	176	3,726
Crawford	3,805,869	34,552	77,397		3,917,818	5,479,609	1.40	179	8,291
Leavenworth	260,329	38,255	49,136	397	348,117	728,374	2.09	235	1,137
Linn	8,471	2,850	260		11,581	21,660	1.87	118	59
Osage	82,120	44,132	196		126,448	317,381	2.51	150	671
Other counties [a]	1,200	6,163			7,363	18,452	2.51	170	32
Small mines		8,100			8,100	18,977	2.34		
Total	5,923,183	154,904	167,024	397	6,245,508	9,292,222	1.49	181	13,916

1909.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Cherokee	2,109,092	45,886	46,969		2,201,947	$3,136,320	$1.42		
Crawford	4,173,141	69,314	85,557		4,328,012	5,902,149	1.36		
Leavenworth	241,172	60,868	18,665	427	321,132	704,408	2.19		
Linn	6,532	1,880	132		8,544	15,339	1.80		
Osage	77,401	22,067	729		100,197	264,454	2.64		
Other counties [b]	4,275	1,629	10		5,914	14,667	2.48		
Small mines		20,732			20,732	46,047	2.22		
Total	6,611,613	222,376	152,062	427	6,986,478	10,083,384	1.44		12,359

[a] Bourbon, Cloud, Franklin, and Republic.
[b] Atchison, Bourbon, Cloud, Franklin, and Republic.

The statistics of production, by counties, during the last five years, with increase and decrease in 1909 as compared with 1908, are shown in the following table:

Coal production of Kansas, 1905–1909, in short tons.

County.	1905.	1906.	1907.	1908.	1909.	Increase (+) or decrease (−), 1909.
Atchison		(a)			(a)	
Cherokee	2,132,589	2,015,107	2,325,744	1,826,081	2,201,947	+ 375,866
Cloud	3,000	3,000	6,512	4,500	800	− 3,700
Crawford	3,729,953	3,415,068	4,380,628	3,917,818	4,328,012	+ 410,194
Franklin	1,950	2,300	3,560	1,604	3,160	+ 1,556
Leavenworth	348,322	377,846	424,338	348,117	321,132	− 26,985
Linn	30,673	32,652	27,488	11,581	8,544	− 3,037
Osage	157,327	137,746	138,049	126,448	100,197	− 26,251
Other counties and small mines	20,165	41,056	16,130	9,359	22,686	+ 13,327
Total	6,423,979	6,024,775	7,322,449	6,245,508	6,986,478	+ 740,970
Total value	$9,350,542	$8,979,553	$11,159,698	$9,292,222	$10,083,384	+$791,162

[a] Included in other counties.

The earliest record of coal production in Kansas shows that the State produced in 1869 a total of 36,891 tons. From 1870 to 1880 the production has been estimated from the best information obtainable, and since 1882 it has been collected by the statistical division of the United States Geological Survey, as shown in the following table, giving the annual production of coal in Kansas from 1869 to the close of 1909:

Production of coal in Kansas, 1869 to 1909, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1869	36,891	1880	771,442	1891	2,716,705	1902	5,266,065
1870	32,938	1881	840,000	1892	3,007,276	1903	5,839,976
1871	41,000	1882	750,000	1893	2,652,546	1904	6,333,307
1872	44,800	1883	900,000	1894	3,388,251	1905	6,423,979
1873	56,000	1884	1,100,000	1895	2,926,870	1906	6,024,775
1874	85,000	1885	1,212,057	1896	2,884,801	1907	7,322,449
1875	150,000	1886	1,400,000	1897	3,054,012	1908	6,245,508
1876	225,000	1887	1,596,879	1898	3,406,555	1909	6,986,478
1877	300,000	1888	1,850,000	1899	3,852,267		
1878	375,000	1889	2,221,043	1900	4,467,870	Total	104,408,190
1879	460,000	1890	2,259,922	1901	4,900,528		

KENTUCKY.

Total production in 1909, 10,697,384 short tons; spot value, $10,079,917.

Development of coal properties was markedly active during 1909 in the eastern district of Kentucky, for which the completion of the Carolina, Clinchfield and Ohio Railway furnished an outlet. The effect of these developments will, however, be shown more in the record for 1910 than appears in the statistics for 1909. The production in 1909 was 10,697,384 short tons, against 10,246,553 tons in 1908, the increase in 1909 amounting to 450,831 short tons, or 4.5 per cent. That the increase was not larger was due to the fact that, owing to the prolonged strike of miners in Alabama in 1908, there was an unusual demand upon the coal mines of Kentucky, particularly those of the eastern district, and the effect of the business depression was not felt to the extent it was in the other States. The strike in Alabama in 1908 kept the tonnage of eastern Kentucky nearly up to the high record of 1907, while the counties in the western part of the State showed a total decrease of nearly 500,000 short tons. In 1909, out of the total increase for the State of 450,831 short tons, the eastern district was credited with 379,666 tons and the western district with 71,165 tons.

In spite of the increase in production in 1909, or possibly because of it and the effort to secure markets for the additional tonnage, the value of the product showed a decided decrease from 1908. The values in the two years were $10,317,162 in 1908 and $10,079,917 in 1909, that of the later year being smaller by $237,245, or 2.3 per cent, as compared with an increase of 4.4 per cent in tonnage. The average price per ton declined from $1.01 in 1908 to 94 cents in 1909, the lowest average recorded in recent years.

There were employed in the coal mines of Kentucky in 1909, 16,903 men, against 16,996 men in 1908. The average production for each employee was 603 tons in 1908 and 633 tons in 1909.

There was only one case of labor trouble reported in 1909. This occurred at the mines of the Eagle Coal Company, in Pulaski County, and resulted in the idleness of 175 men for sixty days, after which 75 returned to work and 100 remained on strike for another sixty days; but this idleness had no influence upon production.

Kentucky is one of the States in which the use of machines for undercutting the coal has shown the greatest advance, over 60 per cent of the total tonnage being mined by machines. In 1909 there were 877 machines in use, and the machine-mined product amounted to 6,461,593 short tons, or 60.5 per cent of the total, against 759 machines and 5,252,753 tons of machine-mined coal, 51.27 per cent of the total, in 1908. Of the 877 machines in use in 1909, 547 were punchers, 308 were chain-breast machines, and 20 were long-wall. Two of the machines in use were of the old style cutter-bar type, now practically obsolete.

Prof. C. J. Norwood, state geologist and chief mine inspector, has maintained for the last twenty-five years complete records of the coal-mine accidents of Kentucky. During that period the fatalities have reached a total of 405, an average of 16 a year; the nonfatal accidents numbered 1,683, an average of 67 a year. Of the total number of deaths, 21 were due to explosions of gas and dust, and 16 of those have occurred in the last two years, 9 in 1908, and 7 in 1909. As usual, falls of roof and coal claimed the largest number of victims, 55 per cent of the deaths and 40 per cent of the injuries being due to that cause. During 1909 there were 34 fatal and 98 nonfatal accidents, a decrease of 5 in the former class and of 29 in the latter, as compared with 1908. Of the 34 fatal accidents in 1909, 7 were due to explosions of gas; falls of roof and coal killed 20, 14 in working places and 6 in gangways; and 2 men were killed by trip cars. Fifteen of the men killed were married and left a total of 39 children. Of the 98 nonfatal accidents, 44 were serious and 54 minor. The death rate per 1,000 employees was 2.01, and there were 314,629 tons mined for each life lost.

There is only one coal-mining establishment in the State at which washing machinery has been installed. This is at the mines of the St. Bernard Mining Company, at Earlington, where 6 Campbell washers have been installed. The number of tons of coal washed in 1909 was 82,086, yielding 72,966 short tons of cleaned coal and 9,120 tons of refuse. The same company reported in 1908, 81,897 short tons of coal washed, yielding 72,798 tons of cleaned coal and 9,099 tons of refuse.

The statistics of production of coal in 1908 and 1909, with the distribution of the product for consumption, are shown in the following table:

Coal production of Kentucky in 1908 and 1909, by counties, in short tons.

1908.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Bell	1,500,143	33,427	24,354	....	1,557,924	$1,696,484	$1.09	211	2,423
Boyd	60,989	80	250	....	61,319	51,548	.84	201	165
Carter	76,193	6,653	700	....	83,546	82,560	.99	148	268
Daviess	....	50,678	477	....	51,155	49,810	.97	126	108
Floyd	46,300	7,400	7,350	....	61,050	63,560	1.04	205	96
Henderson	129,045	58,613	8,365	....	196,023	210,585	1.07	173	350
Hopkins and Christian	1,715,559	55,818	78,110	81,899	1,931,386	1,624,982	.84	217	2,445
Johnson	148,932	4,261	5,077	....	158,270	204,657	1.29	173	294
Knox	499,518	5,554	10,138	....	515,210	570,149	1.11	167	1,001
Laurel	196,622	4,326	6,136	....	207,084	222,113	1.07	166	543
Lee	155,476	2,675	300	....	158,451	236,344	1.49	194	278
McLean	97,899	5,966	1,604	....	105,469	96,840	.92	108	223
Morgan	60,967	8,212	957	....	70,136	164,368	2.34	268	157
Muhlenberg	1,738,112	17,725	28,448	....	1,784,285	1,621,683	.91	179	2,783
Ohio	570,514	13,539	17,085	....	601,138	548,679	.91	162	1,056
Pike	538,120	15,059	8,556	....	561,735	472,629	.84	190	791
Pulaski	94,996	2,474	2,035	....	99,505	138,729	1.39	171	268
Union	438,867	32,045	25,961	2,856	499,729	501,332	1.00	177	736
Webster	514,914	24,640	19,693	....	559,247	484,286	.87	178	767
Whitley	783,548	15,827	11,739	....	811,114	1,049,652	1.29	176	1,983
Other counties [a]	53,800	24,837	2,740	....	81,377	104,601	1.29	138	261
Small mines	....	91,400	....	....	91,400	121,571	1.33	....	....
Total	9,420,514	481,209	260,075	84,755	10,246,553	10,317,162	1.01	186	16,996

1909.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Bell	1,494,571	18,425	24,972	600	1,538,568	$1,595,131	$1.04	....	....
Boyd	85,679	500	725	....	86,904	71,508	.82	....	....
Carter	78,465	2,230	709	....	81,404	79,849	.98	....	....
Christian	41,647	2,106	1,700	....	45,453	33,106	.73	....	....
Daviess	....	60,372	803	....	61,175	62,106	1.01	....	....
Floyd	72,005	1,325	450	....	73,780	68,756	.93	....	....
Henderson	96,807	64,128	2,847	....	163,782	186,326	1.14	....	....
Hopkins	1,639,385	59,761	83,221	82,086	1,864,453	1,427,102	.77	....	....
Johnson	213,860	3,826	5,060	....	222,746	248,429	1.12	....	....
Knox	588,194	8,632	13,879	....	610,705	609,301	1.00	....	....
Laurel	201,419	4,460	8,372	....	214,251	217,097	1.02	....	....
Lawrence	91,573	3,635	1,232	....	96,440	79,199	.82	....	....
Lee	82,769	1,090	250	....	84,109	111,214	1.32	....	....
McLean	109,445	15,932	2,638	....	128,015	113,217	.88	....	....
Morgan	58,867	3,692	1,327	....	63,886	145,948	2.28	....	....
Muhlenberg	1,950,823	18,946	39,780	....	2,009,549	1,691,137	.80	....	....
Ohio	587,262	21,608	17,288	....	626,158	553,037	.88	....	....
Pike	663,987	11,047	8,958	458	684,450	589,652	.86	....	....
Pulaski	55,243	4,880	1,600	....	61,723	77,436	1.25	....	....
Union	381,162	37,728	22,944	2,623	444,457	405,782	.91	....	....
Webster	400,888	34,152	14,468	....	449,508	341,831	.76	....	....
Whitley	909,556	13,441	10,157	....	933,154	1,168,156	1.25	....	....
Other counties [b]	32,905	13,715	100	....	46,720	66,261	1.42	....	....
Small mines	....	105,994	....	....	105,994	138,336	1.31	....	....
Total	9,836,512	511,625	263,480	85,767	10,697,384	10,079,917	.94	....	16,903

[a] Breathitt, Butler, Greenup, Hancock, Knott, Lawrence, Leslie, Magoffin, Menifee, Owsley, and Wayne.
[b] Breathitt, Butler, Hancock, and Wayne.

In the following table is presented a statement of production of coal in Kentucky, by counties, during the last five years, with increase and decrease in 1909 as compared with 1908:

Coal production of Kentucky, 1905–1909, by counties, in short tons.

County.	1905.	1906.	1907.	1908.	1909.	Increase(+) or decrease (−), 1909.
Bell	757,413	989,108	1,437,886	1,557,924	1,538,568	− 19,356
Boyd	48,304	48,822	55,284	61,319	86,904	+ 25,585
Breathitt and Lee	126,937	119,168	87,941	181,551	105,091	− 76,460
Butler	18,199	15,735	10,271	6,858	7,228	+ 370
Carter	145,169	158,748	120,627	83,546	81,404	− 2,142
Christian, Daviess, and Hancock	199,363	161,753	150,248	128,195	121,738	− 6,457
Greenup	1,543	719	902	1,474	....	− 1,474
Henderson	175,226	201,007	217,582	196,023	163,782	− 32,241
Hopkins	2,013,715	2,165,342	2,064,154	1,864,346	1,864,453	+ 107
Johnson	57,310	89,451	122,590	158,270	222,746	+ 64,476
Knox	579,386	549,726	706,491	515,210	610,705	+ 95,495
Laurel	445,958	402,373	319,281	207,084	214,251	+ 7,167
Lawrence	37,481	47,279	29,673	22,975	96,440	+ 73,465
McLean	109,429	168,425	150,205	105,469	128,015	+ 22,546
Muhlenberg	1,050,501	1,492,331	1,882,913	1,784,285	2,009,549	+ 225,264
Ohio	542,327	707,585	658,645	601,138	626,158	+ 25,020
Pulaski	184,319	181,720	135,225	99,505	61,723	− 37,782
Rockcastle	114,356	13,358	6,500	....	....	....
Union	382,956	416,013	507,855	499,729	444,457	− 55,272
Webster	347,817	501,430	608,693	559,247	449,508	− 109,739
Whitley	793,902	781,354	762,923	811,114	933,154	+ 122,040
Other counties and small mines	300,912	442,200	717,235	801,291	931,510	+ 130,219
Total	8,432,523	9,653,647	10,753,124	10,246,553	10,697,384	+ 450,831
Total value	$8,385,232	$9,809,938	$11,405,038	$10,317,162	$10,079,917	−$237,245

Kentucky is the only one of the coal-producing States which has within its borders areas belonging to two of the great coal fields. The eastern counties of the State are underlain by the coal-bearing formations of the great Appalachian system, or province, which extend entirely across the State in a northeast-southwest direction; and the southern limits of the Illinois-Indiana field, designated as the eastern region of the interior province, are found in the more northern counties of the western part of Kentucky. Although the coals of the Appalachian system are superior in quality to those of the interior regions, the western district of Kentucky has been more extensively developed and has produced more coal than the eastern portion. In 1907 the western district produced 40 per cent more than did the eastern district, the counties in the eastern part of the State producing 4,457,727 short tons, and those of the western district 6,295,397 short tons. The eastern counties showed a relative gain in 1908, the output for this district being 4,446,433 short tons, while the western district produced 5,800,120 short tons, the production of the western district being only 30 per cent larger than that of the eastern. With the larger increase in the output of coal in the eastern district, in 1909, which has already been referred to, a further gain was made upon the western rival, the western counties producing 5,871,285 tons and the eastern counties 4,826,099 tons. The output from the western district in 1909 was 1,045,186 short tons, or 22 per cent, more than the eastern. In 1906 the production of the western district exceeded that of the eastern by over 2,000,000 tons.

The following tables show the production in the eastern and western districts, by counties, during the last five years, with increase and decrease in 1909 as compared with 1908:

Coal production of the eastern district of Kentucky, 1905–1909, in short tons.

County.	1905.	1906.	1907.	1908.	1909.	Increase (+) or decrease (−), 1909.
Bell	757,413	989,108	1,437,886	1,557,924	1,538,568	− 19,356
Boyd	48,304	48,822	55,284	61,319	86,904	+ 25,585
Breathitt	32,340	37,350	25,300	23,100	20,982	− 2,118
Carter	145,169	158,748	120,627	83,546	81,404	− 2,142
Greenup	1,543	719	902	1,474	....	− 1,474
Johnson	57,310	89,451	122,590	158,270	222,746	+ 64,476
Knox	579,386	549,726	706,491	515,210	610,705	+ 95,495
Laurel	445,958	402,373	319,281	207,084	214,251	+ 7,167
Lawrence	37,481	47,279	29,673	22,975	96,440	+ 73,465
Lee	94,597	81,818	62,641	158,451	84,109	− 74,342
Pulaski	184,319	181.720	155,225	99,505	61,723	− 37,782
Rockcastle	114,356	13,358	6,500	....	....	....
Whitley	793,902	781,354	762 923	811,114	933,154	+122,040
Other counties and small mines	214,519	386,825	672,404	746,461	875,113	+128,652
Total	3,506,597	3,768,651	4,457,727	4,446,433	4,826,099	+379,666

Coal production of the western district of Kentucky, 1905–1908, in short tons.

County.	1905.	1906.	1907.	1908.	1909.	Increase (+) or decrease (−), 1909.
Butler	18,199	15,735	10,271	6,858	7,228	+ 370
Christian	89,766	80,065	62,901	67,040	45,453	− 21,587
Daviess	61,780	52,643	73,907	51,155	61,175	+ 10,020
Hancock	47,817	29,045	13,440	10,000	15,110	+ 5,110
Henderson	175,226	201,007	217,582	196,023	163,782	− 32,241
Hopkins	2,013,715	2,165,342	2,064,154	1,864,346	1,864,453	+ 107
McLean	109,429	168,425	150,205	105,469	128,015	+ 22,546
Muhlenberg	1,050,501	1,492,331	1,882,913	1,784,285	2,009,549	+225,264
Ohio	542,327	707,585	658,645	601,138	626,158	+ 25,020
Union	382,956	416,013	507,855	499,729	444,457	− 55,272
Webster	347,817	501,430	608,693	559,247	449,508	−109,739
Other counties and small mines	86,393	55,375	44,831	54,830	56,397	+ 1,567
Total	4,925,926	5,884,996	6,295,397	5,800,120	5,871,285	+ 71,165

So far as the records of early coal production in the United States are to be accepted, Kentucky was the third State to enter the list of regular coal producers. According to one of the early reports of the Kentucky Geological Survey (published in 1838), the first coal produced in the State was mined in 1827 on "the right side of the (Cumberland) river below the mouth of Laurel." This was evidently from either Laurel or Pulaski County, but the exact location is not definitely stated. The same report says that in 1828 five boatloads of coal from these mines arrived at Nashville, and that from 1829 to 1834 probably from 25 to 35 boatloads were sent out each year. The boatloads averaged about 1,750 bushels, or 66 tons, each. From 1834 to 1837 the shipments were from 75 to 100 boatloads, or about 3,500 bushels, a year. The coal was for the most part consumed in the salt works and iron furnaces convenient to the rivers, the only means of transportation.

From the best information obtainable it seems that the production of the State from 1829 to 1835 ranged from 2,000 to 6,000 tons per year. The United States census for 1840 gives the total production for the State at 23,527 short tons. By 1860, according to the census for that year, the production amounted to 285,760 short tons. Operations were necessarily somewhat interrupted during the Civil War, but since 1870, after the State had begun to recover from the effects of the war, the production increased rapidly, as is shown in the table following, which gives the history of coal production in Kentucky from the earliest times to the close of 1909:

Production of coal in Kentucky from 1828 to 1909, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1828	328	1849	140,000	1870	150,582	1891	2,916,069
1829	2,009	1850	150,000	1871	250,000	1892	3,025,313
1830	2,000	1851	160,000	1872	380,800	1893	3,007,179
1831	2,100	1852	175,000	1873	400,000	1894	3,111,192
1832	2,500	1853	180,000	1874	360,000	1895	3,357,770
1833	2,750	1854	190,000	1875	500,000	1896	3,333,478
1834	5,000	1855	200,000	1876	650,000	1897	3,602,097
1835	6,000	1856	215,000	1877	850,000	1898	3,887,908
1836	8,000	1857	240,000	1878	900,000	1899	4,607,255
1837	10,000	1858	250,000	1879	1,000,000	1900	5,328,964
1838	11,500	1859	275,000	1880	946,288	1901	5,469,986
1839	16,000	1860	285,760	1881	1,232,000	1902	6,766,984
1840	23,527	1861	280,000	1882	1,300,000	1903	7,538,032
1841	35,000	1862	275,000	1883	1,650,000	1904	7,576,482
1842	50,000	1863	250,000	1884	1,550,000	1905	8,432,523
1843	60,000	1864	250,000	1885	1,600,000	1906	9,653,647
1844	75,000	1865	200,000	1886	1,550,000	1907	10,753,124
1845	100,000	1866	180,000	1887	1,933,185	1908	10,246,553
1846	115,000	1867	175,000	1888	2,570,000	1909	10,097,384
1847	120,000	1868	160,000	1889	2,399,755		
1848	125,000	1869	160,000	1890	2,701,496	Total	143,348,511

MARYLAND.

Total production in 1909, 4,023,241 short tons; spot value, $4,471,731.

Maryland's production of coal, which decreased from 5,532,628 short tons in 1907 to 4,377,093 short tons in 1908, a loss of 1,155,535 tons, showed a further decrease of 353,852 short tons to 4,023,241 tons in 1909. The percentage of decrease in 1908 was 20.9; in 1909 it was 8. The value in each year has shown a larger decrease than the decrease in production. In 1907 the value was $6,623,697, decreasing $1,506,944, or 22.8 per cent, to $5,116,753 in 1908, and $645,022, or 12.6 per cent, to $4,471,731 in 1909. The average price per ton declined from $1.20 in 1907 to $1.17 in 1908 and to $1.11 in 1909, the average for 1909 being the lowest since 1905.

The decreased production of coal in Maryland in the last two years appears to be due to the approaching exhaustion of the "Maryland Big Vein," as is called that portion of the Pittsburg bed which has furnished the larger part of Maryland tonnage, popularly known as Georges Creek coal. In reply to inquiries from the writer asking for the cause for the falling off as shown in the returns for 1909, a number of the larger operators have stated that the properties are nearly at their end and production is being reduced in consequence. It will probably not be many years before the thinner and deeper beds will be furnishing the markets formerly controled by the "Big Vein" coal, but this will be at a greater cost of mining and a higher price or less profit for the product. In the aggregate the quantity of coal that may be won from these thinner beds far exceeds the original contents of the celebrated "Big Vein." Increased competition with West Virginia coal, particularly that coming from the fields opened up by the new Virginian Railway, may be assigned as the chief cause for the decline of price for Maryland coal in 1908 and 1909.

There were 39 mining machines reported as owned by the coal-mining companies of Maryland in 1909, but all of them were not in use. The machine-mined tonnage decreased from 208,134 short tons in 1908 to 117,568 tons in 1909, or 2.9 per cent of the total production. The number of machines reported in 1909 was the same as in 1908. None of the Maryland coal is washed.

The only labor trouble in 1909 was a strike of 25 men at one mine, but as the men were out only seven days the idleness did not affect the production.

The fiscal year covered by the mine inspector's report for Maryland ends on May 31. During a period of thirteen years there have been 124 fatal and 283 nonfatal accidents in the mines of this State. The causes of the accidents have been furnished to the Geological Survey by Mr. John H. Donahue, mine inspector, for the last two years, in which there were 29 fatalities and 172 men injured, none of the accidents during the thirteen years being due to explosions. In 1909 there were 93 accidents, 17 being fatal. Of the 17 fatalities in 1909, all but 4 were due to falls of roof or coal, and 47 of the 76 nonfatal accidents were due to this cause.

The statistics of production during the last five years, with the distribution of the product for consumption, are shown in the following table:

Distribution of the coal product of Maryland, 1905–1909, in short tons.

Year.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
1905	5,010,997	49,779	47,763	5,108,539	$5,831,760	$1.14	252	5,948
1906	5,331,321	50,306	53,826	5,435,453	6,474,793	1.19	250	6,438
1907	5,427,882	48,461	56,285	5,532,628	6,623,697	1.20	263	5,880
1908	4,288,306	38,054	50,733	4,377,093	5,116,753	1.17	220	6,079
1909	3,917,803	55,882	49,556	4,023,241	4,471,731	1.11	....	8,004

Although coal was discovered in the Georges Creek basin as early as 1782, the first eastern shipments from the Maryland coal district were not made until 1830, when small quantities were transported by barges down the Potomac River. The first company was incorporated in 1836. After the construction of the Baltimore and Ohio Railroad, in 1842, and of the Chesapeake and Ohio Canal, in 1850, the output from the Maryland mines increased rapidly.

The attempts to ship coal from the Maryland mines by barges, prior to the advent of the Baltimore and Ohio Railroad, were not long continued. The method was too destructive of life and was the cause of so much loss in coal that it was soon abandoned, and it was not until

1842 that the industry really began to assume importance. The first shipments over the Chesapeake and Ohio Canal from Cumberland were made in 1850.

Maryland and the adjoining counties in West Virginia which make up what is known as the Cumberland region, constitute the only districts outside of the anthracite region of Pennsvlvania where records of coal production have been kept from the earliest years. These districts have been commonly known as the Georges Creek or Cumberland and the Piedmont regions. The Cumberland region was opened in 1842; the Piedmont region began shipping in 1853. The records of shipments have been carefully preserved and are published annually in the reports of the Cumberland Coal Trade.

The annual production since mining began in Maryland in 1820 is shown in the following table:

Production of coal in Maryland from 1820 to 1909, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1820	3,000	1858	722,686	1877	1,939,575	1896	4,143,936
1832	12,000	1859	833,349	1878	2,068,925	1897	4,442,128
1840	8,880	1860	438,000	1879	2,132,233	1898	4,674,884
1842	2,104	1861	287,073	1880	2,228,917	1899	4,807,396
1843	12,421	1862	346,201	1881	2,533,348	1900	4,024,688
1844	18,345	1863	877,313	1882	1,555,445	1901	5,113,127
1845	30,372	1864	755,764	1883	2,476,075	1902	5,271,609
1846	36,707	1865	1,025,208	1884	2,765,617	1903	4,846,165
1847	65,222	1866	1,217,668	1885	2,833,337	1904	4,813,622
1848	98,032	1867	1,381,429	1886	2,517,577	1905	5,108,539
1849	175,497	1868	1,529,879	1887	3,278,023	1906	5,435,453
1850	242,517	1869	2,216,300	1888	3,479,470	1907	5,532,628
1851	317,460	1870	1,819,824	1889	2,939,715	1908	4,377,093
1852	411,707	1871	2,670,338	1890	3,357,813	1909	4,023,241
1853	657,862	1872	2,647,156	1891	3,820,239		
1854	812,727	1873	3,198,911	1892	3,419,962	Total	156,006,882
1855	735,137	1874	2,899,392	1893	3,716,041		
1856	817,659	1875	2,808,018	1894	3,501,428		
1857	654,017	1876	2,126,873	1895	3,915,585		

MICHIGAN.

Total production in 1909, 1,784,692 short tons; spot value, $3,199,351.

The prediction contained in the preliminary review of the coal trade in 1909, published in the latter part of December of that year, that the coal output of Michigan in 1909 would show a reduction as compared with 1908, was borne out by the reports of production received from the operators. During the ten years preceding 1909 the development of coal-mining properties in Michigan was energetically carried forward until, as has been the record in many other districts, the ability to produce exceeded the capacity to absorb the product. As a result of this condition and also of active competition of coals from other States, driven by the dullness of the iron trade to seek other markets, a number of the coal mines in Michigan were forced to close down in 1909. The effect is exhibited in a decrease in production from 1,835,019 short tons in 1908 to 1,784,692 tons in 1909. The difference was not great, only a little more than 50,000 tons, and less than 3 per cent, but the significance lies in the fact that 1909 was a year of general increase in production, and Michigan was one of but six States in which the tonnage won in 1909 was less than in 1908. The value of the product declined from $3,322,904 to $3,199,351, a loss of $123,553, or 3.7 per cent.

The larger part of the coal production of Michigan is from Bay and Saginaw counties, and is nearly equally divided between the two, Bay County producing in 1909, 822,577 short tons, and Saginaw County 859,434 tons. The aggregate for the two counties was 1,682,011 short tons, or 94 per cent of the total for the State. The other counties in which coal was produced were Clinton, Eaton, Ingham, Jackson, Shiawassee, and Tuscola, the aggregate production of which in 1909 was 102,681 short tons.

The coal mines of Michigan gave employment in 1909 to 3,496 men against 4,247 men in 1908. The average production per man was 432 tons in 1908 and 510 tons in 1909. During 1909 there were 101 machines used in the undercutting of the coal, and of the total of 1,784,692 short tons produced, 511,895 tons, or 28.7 per cent, were machine mined. In 1908, 120 machines were used and 535,543 tons, or 29.18 per cent of the total, were machine mined. Of the 101 machines in use in 1909, 66 were punchers, 34 were chain breast, and one was a long-wall machine.

According to Mr. M. J. McLeod, the Michigan commissioner of labor and industrial statistics, there were 113 accidents in the coal mines of the State in 1909. Of these, 9 were fatal and 104 nonfatal. The nonfatal accidents consisted of 12 serious and 92 minor injuries. The causes of the accidents and the conjugal condition of the men killed were not reported. The death rate for each thousand employees was 2.57, and there were 198,299 tons of coal mined for each life lost. In 1908 the death rate was 1.18 per 1,000, and the quantity of coal mined for each fatality was 367,004 tons.

The statistics of the production of coal in Michigan, by counties, during 1908 and 1909, with the distribution of the production for consumption, are shown in the following table:

Coal production of Michigan in 1908 and 1909, by counties, in short tons.

1908.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Bay	725,253	26,098	31,152	782,503	$1,396,846	$1.79	206	1,770
Clinton, Eaton, Jackson, and Tuscola[a]	34,570	14,144	4,464	53,178	112,526	2.12	197	150
Saginaw	914,602	46,981	37,755	999,338	1,813,532	1.81	208	2,327
Total	1,674,425	87,223	73,371	1,835,019	3,322,904	1.81	207	4,247

1909.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Bay	770,206	19,840	32,531	822,577	$1,486,629	$1.81	....	....
Saginaw	766,031	65,088	28,315	859,434	1,524,933	1.77	....	....
Other counties[b] and small mines	82,984	10,267	9,430	102,681	187,789	1.83	....	....
Total	1,619,221	95,195	70,276	1,784,692	3,199,351	1.79	....	3,496

[a] Includes the output of small mines.
[b] Clinton, Eaton, Ingham, Jackson, Shiawassee, and Tuscola.

The statistics of production, by counties, during the last five years, with increase and decrease in 1909 as compared with 1908, are shown in the following table:

Coal production of Michigan, 1905–1909, by counties, in short tons.

County.	1905.	1906.	1907.	1908.	1909.	Increase (+) or decrease (−), 1909.
Bay	544,154	481,398	962,574	782,503	822,577	+ 40,074
Eaton	4,058	18,507	5,982	2,286	558	− 1,728
Jackson	9,196	8,658	5,645	5,539	1,500	− 4,039
Saginaw	915,803	835,475	1,047,927	999,338	859,434	− 139,904
Shiawassee		[a] 2,300	13,730	[b] 45,353	[c] 100,623	+ 55,270
Total	1,473,211	1,346,338	2,035,858	1,835,019	1,784,692	− 50,327
Total value	$2,512,697	$2,427,404	$3,660,833	$3,322,904	$3,199,351	−$123,553

[a] Including the output of small mines.
[b] Clinton and Tuscola counties and small mines.
[c] Includes Clinton, Ingham, and Tuscola counties and small mines.

The coal fields of Michigan are confined entirely to the lower peninsula, and, with the exception of the extreme northern part of the Appalachian region, are the only ones within the drainage area of the Great Lakes. The developments have been principally in the eastern portion of the fields and in a line running from Bay City, on the north, to Jackson, at the southern extremity of the coal basin.

Coal was known to exist in Michigan early in the last century, and some mining is said to have been done in the Jackson field as early as 1835. Other mines were opened at Grand Ledge, in Clinton County, in 1838. It is known that some coal was produced at that place in those early years, but there is no record of the output prior to the census report of 1860, in which year Michigan was credited with a production of 2,320 tons. The development of mining in this field has, however, been tardy, owing largely to the fact that one of the principal industries of the vicinity, the manufacture of salt, had been carried on in connection with sawmills, and that the sawdust and other refuse from these mills were used as fuel. Wood also formed the chief fuel for other manufacturing industries and for domestic use. It was only in the closing decade of the last century that serious attention began to be paid to the coal resources of the State, and prior to 1896 the production had exceeded 100,000 tons during four years only. In 1897 it exceeded 200,000 tons; in 1899 it exceeded 600,000 tons; and in the first year of the present century it reached a total exceeding 1,200,000 tons. The maximum output of 2,035,858 tons was reached in 1907.

The record, by years, from 1860 to the close of 1909 is shown in the following table:

Production of coal in Michigan, 1860 to 1909, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1860	2,320	1873	56,000	1886	60,434	1899	624,708
1861	3,000	1874	58,000	1887	71,461	1900	849,475
1862	5,000	1875	62,500	1888	81 407	1901	1,241,241
1863	8,000	1876	66,000	1889	67,431	1902	964,718
1864	12,000	1877	69,197	1890	74,977	1903	1,367,619
1865	15,000	1878	85,322	1891	80,307	1904	1,342,840
1866	20,000	1879	82,015	1892	77,990	1905	1,473,211
1867	25,000	1880	100,800	1893	45,979	1906	1,346,338
1868	28,000	1881	112,000	1894	70,022	1907	2,035,858
1869	29,980	1882	135,339	1895	112,322	1908	1,835,019
1870	28,150	1883	71,296	1896	92,882	1909	1,784,692
1871	32,000	1884	36,712	1897	223,592		
1872	33,600	1885	45,178	1898	315,722	Total	17,462,654

MISSOURI.

Total production in 1909, 3,756,530 short tons; spot value, $6,183,626.

Missouri reached the high tide of coal production in 1903, when a total of 4,238,586 short tons was produced. Since that date there has been a decreasing tendency to the low record for recent years of 3,317,315 tons in 1908. In 1909 the State shared in the general recovery from the depression of the preceding year with an increase of 439,215 short tons to 3,756,530 tons. The increase in value was $738,719, from $5,444,907 in 1908 to $6,183,636 in 1909.

The prospects for any marked increase in the production of coal in Missouri are not favorable. Surrounded as it is by other coal-producing States, Iowa on the north, Illinois and Kentucky on the east, and Arkansas, Oklahoma, and Kansas on the south and west, the output of the Missouri mines is restricted to comparatively local markets. Moreover, the larger cities of the State which are near the boundary lines draw their fuel supplies from other fields. St. Louis secures its fuel from the more accessible fields of southeastern Illinois, and Kansas City depends to a large extent upon Arkansas, Kansas, and Oklahoma for coal. But a more potential factor in limiting the demand for Missouri coal in the last few years has been the notable increase in the production of petroleum and natural gas in the mid-continent field of Kansas and Oklahoma. Natural gas from eastern Kansas is now piped to Kansas City, St. Joseph, and Joplin, Mo., and to Atchison, Leavenworth, and other cities in Kansas. Oil from the same district and from northern Oklahoma is being extensively used as fuel for manufacturing purposes in Kansas City and other cities contiguous to the Missouri coal fields, and as long as these more desirable fuels are available the demand for Missouri coal is not likely to increase materially.

To Missouri's coal production as given in these reports for the last few years should be added a considerable tonnage credited to Kansas. The workings of the mines at Leavenworth, Kans., on Missouri River, extend under that boundary line into Missouri territory, and the larger part of the production of Leavenworth County, Kans., is, in fact, mined in Platte County, Mo. This probably amounts to 250,000 tons a year. It has been customary, however, when mine workings extend from one State or county into another, to credit the production to the State or county in which the tipple is located. For this reason the tonnage from Platte County, Mo., appears as coming from Leavenworth County, Kans.

The number of men employed in the coal mines of Missouri in 1909 was 9,188 against 8,988 in 1908, an increase of 200. The quantity of coal mined per man was 369 tons in 1908 and 409 tons in 1909. There was no serious interruption to mining operations by strikes or suspensions, most of the troubles that occurred being of only a few days' duration.

The use of mining machines for undercutting coal in Missouri is almost entirely confined to the thin beds where machines of the long-wall type can be used to advantage. In 1909 there were 96 machines in use, of which 74 were long-wall, and 18 were punchers, against 57 machines, of which 52 were long-wall, and 5 punchers, in 1908. Four chain-breast machines were used in 1909. The machine-mined production increased from 479,850 short tons, or 14.47 per cent of the total, in 1908, to 796,438 tons, or 21.2 per cent of the total, in 1909.

But one coal producer in Missouri reported the use of washing machinery in 1909. Four jigs were employed, and 78,100 tons of coal were washed, yielding 60,121 tons of cleaned coal, and 17,979 tons of refuse.

In the preliminary statement on the accidents in coal mines, published as a Survey "press bulletin" in June, 1910, the authority for information regarding the accidents in Missouri was erroneously credited to a former secretary of the State bureau of mines. Acknowledgment should then have been, and is now, made to Mr. George Bartholomaeus, the present secretary of the bureau. Mr. Bartholomaeus, in addition to furnishing the statistics for 1909, has kindly prepared a complete record of the coal-mine accidents in the State since 1890. As the figures for Missouri were incomplete in the preliminary statement, the table prepared by Mr. Bartholomaeus is given below. In 1909 there were 44 accidents, 21 fatal and 23 nonfatal. Thirteen wives were made widows and 47 children were left fatherless. Fourteen of the fatal accidents, two-thirds of the total, were due to falls of roof and coal, 3 to powder explosions, and 3 to shaft accidents. None were due to explosions of gas or dust. The death rate per 1,000 men employed was 2.29, and there were 178,882 tons mined for each life lost. The record of accidents for the last 20 years, prepared by Mr. Bartholomaeus, is shown in the following table:

Coal-mining accidents in Missouri since 1890.

Year.	Gas and dust explosions.		Powder explosions and windy shots.		Falls of roof or coal.		Other causes.		Total.	
	Killed.	Injured.	Killed.	Injured.	Killed.	Injured.	Killed.	Injured.	Killed.	Injured.
1890	1	2	4	3	6	14	0	8	11	27
1891	0	0	0	2	10	23	8	7	18	32
1892	0	0	3	8	13	27	5	5	21	40
1893	3	1	0	1	12	13	6	11	21	26
1894	5	7	0	3	11	12	3	5	19	27
1895	0	0	1	3	8	6	4	6	13	15
1896	0	0	4	0	12	10	3	7	19	17
1897	0	3	0	0	6	16	2	4	8	23
1898	0	3	0	0	6	18	3	6	9	27
1899	0	0	2	0	9	16	3	7	14	23
1900	0	0	0	0	9	19	1	4	10	23
1901	0	0	3	7	9	6	3	3	15	16
1902	0	0	1	0	6	16	3	2	10	18
1903	3	1	0	2	10	12	4	7	17	22
1904	0	0	2	1	8	11	1	4	11	16
1905	0	0	1	1	8	23	2	12	11	36
1906	0	0	0	2	13	18	3	7	16	27
1907	0	0	1	1	6	19	1	3	8	23
1908	0	0	0	0	9	24	1	13	10	37
1909	0	0	3	2	14	17	4	4	21	23
Total	12	17	25	36	185	320	60	125	282	498

The statistics of coal production in Missouri in 1908 and 1909, by counties, with the distribution of the product for consumption, are shown in the following table:

Coal production of Missouri in 1908 and 1909, by counties, in short tons.

1908.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Adair	572,960	21,537	5,855	600,352	$875,398	$1.46	189	1,220
Audrain	23,009	12,697	1,773	37,479	75,185	2.01	248	120
Barton	121,330	4,926	3,376	129,632	185,939	1.43	150	420
Bates	112,670	19,588	1,442	133,700	217,730	1.63	140	346
Boone	....	25,868	....	25,868	50,436	1.95	236	50
Callaway	1,500	21,034	....	22,534	44,820	1.99	112	95
Henry	208,650	10,019	1,305	219,974	372,335	1.69	157	449
Lafayette	547,931	38,120	9,627	595,678	1,095,640	1.84	182	1,850
Linn	79,316	22,608	1,180	103,104	223,497	2.17	194	360
Macon	806,558	13,440	13,062	833,060	1,176,958	1.41	149	2,121
Putnam	48,292	1,822	661	50,775	85,963	1.69	145	214
Randolph	43,210	22,181	1,000	66,391	111,770	1.68	175	160
Ray	237,054	21,957	4,277	263,288	470,714	1.79	151	1,112
Other counties [a]	125,168	43,350	3,156	171,674	332,434	1.94	217	471
Small mines	....	63,806	....	63,806	126,088	1.98	....	....
Total	2,927,648	342,953	46,714	3,317,315	5,444,907	1.64	169	8,988

1909.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Adair	552,221	15,376	8,888	576,485	$847,298	$1.47	....	....
Audrain	21,825	19,202	180	41,207	77,835	1.89	....	....
Barton	242,621	6,942	10,203	259,766	358,742	1.38	....	....
Bates	130,510	13,733	3,079	147,322	235,558	1.60	....	....
Boone	....	17,854	146	18,000	35,340	1.96	....	....
Callaway	....	25,127	52	25,179	65,223	2.59	....	....
Henry	222,903	36,101	4,348	263,352	441,394	1.68	....	....
Lafayette	648,443	47,421	19,359	715,223	1,293,999	1.81	....	....
Linn	109,215	22,949	2,096	134,260	290,952	2.17	....	....
Macon	767,162	15,490	7,431	790,083	1,126,250	1.43	....	....
Putnam	45,993	1,238	889	48,120	78,628	1.63	....	....
Ralls	14,646	1,363	....	16,009	29,393	1.84	....	....
Randolph	166,458	14,805	5,310	186,573	282,693	1.52	....	....
Ray	246,166	26,466	4,443	277,075	514,316	1.86	....	....
Other counties [b]	76,437	48,126	3,963	128,526	255,147	1.99	....	....
Small mines	....	129,350	....	129,350	250,858	1.94	....	....
Total	3,244,600	441,543	70,387	3,756,530	6,183,626	1.65	....	9,188

[a] Benton, Caldwell, Carroll, Cass, Chariton, Clay, Dade, Grundy, Howard, Johnson, Livingston, Moniteau, Monroe, Montgomery, Morgan, Pettis, Ralls, St. Clair, Schuyler, and Vernon.
[b] Benton, Caldwell, Cass, Clay, Cole, Dade, Grundy, Harrison, Howard, Johnson, Livingston, Moniteau, Monroe, Montgomery, Morgan, Schuyler, Sullivan, and Vernon.

The statistics of production during the last five years, by counties, with increase and decrease in 1909 as compared with 1908, are shown in the following table:

Coal production in Missouri, 1905–1909, by counties, in short tons.

County.	1905.	1906.	1907.	1908.	1909.	Increase (+) or decrease (−), 1909.
Adair	603,699	442,035	585,491	600,352	576,485	− 23,867
Audrain	53,123	34,233	38,265	37,479	41,207	+ 3,728
Barton	241,113	218,623	193,418	129,632	259,766	+ 130,134
Bates	167,872	210,218	115,285	133,700	147,322	+ 13,622
Boone	40,786	40,626	33,034	25,868	18,000	− 7,868
Caldwell	15,000	14,000	15,000	10,600	7,815	− 2,785
Callaway	17,306	41,162	34,413	22,534	25,179	+ 2,645
Grundy		7,990	11,040	10,821	9,818	− 1,003
Henry	125,988	115,679	209,652	219,974	263,352	+ 43,378
Johnson	1,712	2,383	10,543	13,571	8,128	− 5,443
Lafayette	667,023	679,679	717,588	595,678	715,223	+ 119,545
Linn	95,175	95,326	117,403	103,104	134,260	+ 31,156
Livingston	2,825	2,000	2,010	1,010	400	− 610
Macon	799,513	770,284	1,156,140	833,060	790,083	− 42,977
Montgomery and Morgan				2,783	2,420	− 363
Putnam	79,162	104,899	51,675	50,775	48,120	− 2,655
Ralls	14,557	17,510	12,024	11,802	16,009	+ 4,207
Randolph	491,404	371,386	72,500	66,391	186,573	+ 120,182
Ray	236,598	276,341	337,384	263,288	277,075	+ 13,787
Vernon	195,201	140,570	141,379	47,281	20,278	− 27,003
Other counties and small mines	135,321	173,064	143,692	137,612	209,017	+ 71,405
Total	3,983,378	3,758,008	3,997,936	3,317,315	3,756,530	+ 439,215
Total value	$6,291,661	$6,118,733	$6,540,709	$5,444,907	$6,183,626	+$738,719

A statement of the annual production of coal in Missouri from 1840 to the close of 1909 will be found in the following table:

Production of coal in Missouri from 1840 to 1909, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1840	9,972	1858	240,000	1876	1,008,000	1894	2,245,039
1841	12,000	1859	260,000	1877	1,008,000	1895	2,372,393
1842	15,000	1860	280,000	1878	1,008,000	1896	2,331,542
1843	25,000	1861	300,000	1879	1,008,000	1897	2,665,626
1844	35,000	1862	320,000	1880	844,304	1898	2,688,321
1845	50,000	1863	360,000	1881	1,960,000	1899	3,025,814
1846	68,000	1864	375,000	1882	2,240,000	1900	3,540,103
1847	80,000	1865	420,000	1883	2,520,000	1901	3,802,088
1848	85,000	1866	450,000	1884	2,800,000	1902	3,890,154
1849	90,000	1867	500,000	1885	3,080,000	1903	4,238,586
1850	100,000	1868	541,000	1886	1,800,000	1904	4,168,308
1851	125,000	1869	550,000	1887	3,209,916	1905	3,983,378
1852	140,000	1870	621,930	1888	3,909,967	1906	3,758,008
1853	160,000	1871	725,000	1889	2,557,823	1907	3,997,936
1854	175,000	1872	784,000	1890	2,735,221	1908	3,317,315
1855	185,000	1873	784,000	1891	2,674,606	1909	3,756,530
1856	200,000	1874	789,680	1892	2,733,949		
1857	220,000	1875	840,000	1893	2,897,442	Total	104,691,951

MONTANA.

Total production in 1909, 2,553,940 short tons; spot value, $5,036,942.

Montana, in the production of coal in 1909, outstripped all previous records, exceeding the earlier high level of 2,016,857 short tons, made in 1907, by 537,083 short tons, or 26.6 per cent. Compared with 1908, when the output was 1,920,190 short tons, the production in 1909 showed an increase of 633,750 short tons, or 33 per cent. The value increased in slightly greater proportion, from $3,771,248 to $5,036,942, a gain of $1,265,694, or 33.6 per cent. The average price per ton was $1.97 in 1909 against $1.96 in 1908. The increased production was general throughout the State, but the most important factor was the effect of the developments in the Bull Mountain field, near Billings, in Fergus and Yellowstone counties. Prior to 1909 no commercial production had been reported from Yellowstone County. Development of the Bull Mountain field began in 1908, following the advent of the Chicago, Milwaukee and Puget Sound Railway, and in 1909 nearly 400,000 tons were produced, of which approximately 200,000 tons was mined in Yellowstone County. Large increases were exhibited also in the older coal-producing districts. Carbon County, in which the Red Lodge field is worked, increased its production 121,552 short tons. The Cottonwood-Belt district in Cascade County, gained 143,412 tons, but did not attain the tonnage made in either 1906 or 1907. Fergus County, where the Judith Basin field is worked, and which also contains a part of the Bull Mountain field, showed the largest percentage of gain of all the older coal-producing counties, its production having increased from 90,318 short tons in 1908 to 221,663 tons in 1909, a gain of 131,345 tons, or nearly 150 per cent. The increase came from the Bull Mountain developments. Park County production increased over 30 per cent, from 106,942 tons to 139,464 tons.

Montana's notable increase in coal production was due principally to the revival of the metal-mining industry and to bountiful crops, which brought generally prosperous conditions throughout the State. Mining operations were not interfered with by strikes, suspensions, or lockouts, the only labor disaffection being one strike of 10 days' duration, and although there was some shortage of cars among the fruit and grain shippers, the coal mines seem to have had a sufficient supply for their needs.

The reports made jointly to the Geological Survey and the Bureau of the Census show that in 1909 there were 81 mining machines employed in the coal mines of Montana, and that the machine-mined product amounted to 840,686 short tons, or 32.9 per cent of the total output of the State, an increase, as compared with 1908, of 24 in the number of machines and of 127,469 short tons in the quantity of coal undercut by them. In 1907, 984,368 tons, or 50 per cent of the total, was machine mined. Of the 81 machines in use in 1909, 71 were pick machines, 8 were of the chain-breast type; 1 was a "continuous cutter," or short-wall machine, and 1 was a pick shearing machine. Two of the machines were used in development work and did not add materially to the machine-mined tonnage.

According to Mr. J. B. McDermott, state mine inspector, there have been in the coal mines of Montana since 1890 161 fatal and 360 nonfatal accidents. Among these there has been none of a fatal character due to explosions, though 20 men were injured in such accidents. Nearly half of both the fatal and the nonfatal accidents were due to falls of roof and coal.

It is gratifying to note that, although the production of coal in Montana in 1909 increased about 30 per cent over that in 1908, the number of fatal accidents decreased from 21 to 11 and the nonfatal accidents from 58 to 44. The production in 1909 was 2,553,940 short tons, indicating that for each life lost 232,176 tons were mined. The death rate per thousand employees was 2.43. In 1908 the death rate was 6.36 per thousand and the quantity mined for each life lost was 96,010 tons.

The slight difference between the tonnage reported by Mr. McDermott and that reported to the Geological Survey and the Bureau of the Census (a difference of about 12,000 tons), is probably due to the inclusion in the latter report of the production from small local mines which do not come within the purview of the mine-inspection laws.

The statistics of production, by counties, in 1908 and 1909, with the distribution of the product for consumption, are shown in the following table:

Coal production of Montana in 1908 and 1909, by counties, in short tons.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
1908.									
Carbon	811,272	22,165	34,675		868,112	$1,689,962	$1.95	226	1,646
Cascade	758,761	24,593	27,891		811,245	1,370,948	1.69	214	993
Chouteau	16,500	2,870	400		19,770	46,703	2.36	161	43
Fergus	46,600	42,398	1,320		90,318	268,826	2.98	199	116
Park	40,160	1,044	6,470	59,268	106,942	343,760	3.21	283	280
Other counties [a]	6,254	6,921	8,773		21,948	46,453	2.12	151	68
Small mines		1,855			1,855	4,596	2.48		
Total	1,679,547	101,846	79,529	59,268	1,920,190	3,771,248	1.96	224	3,146
1909.									
Carbon	930,545	26,219	32,900		989,664	$2,091,007	$2.11		
Cascade	897,224	24,804	32,629		954,657	1,649,036	1.73		
Chouteau	14,622	15,810	1,000		31,432	68,207	2.17		
Fergus	196,740	19,991	4,932		221,663	457,793	2.07		
Park	39,335	4,329	12,827	82,973	139,464	282,517	2.02		
Other counties [b]	177,695	3,321	28,487	25	209,528	472,325	2.25		
Small mines		7,532			7,532	16,057	2.01		
Total	2,256,161	102,006	112,775	82,998	2,553,940	5,036,942	1.97		4,535

[a] Custer, Gallatin, Rosebud, and Valley.
[b] Broadwater, Custer, Gallatin, Granite, Missoula, Rosebud, and Yellowstone.

In the following table is presented a statement of the coal production of Montana, by counties, during the last five years, with increase and decrease in 1909 as compared with 1908:

Production of coal in Montana, 1905–1909, by counties, in short tons.

County.	1905.	1906.	1907.	1908.	1909.	Increase (+) or decrease (−), 1909.
Carbon	588,414	557,148	746,110	868,112	989,664	+ 121,552
Cascade	826,026	1,027,923	1,026,223	811,245	954,657	+ 143,412
Chouteau	6,500	12,305	24,847	19,770	31,432	+ 11,662
Fergus	15,228	29,182	45,760	90,318	221,663	+ 131,345
Gallatin	123,006	97,926	69,257	15,973	16,771	+ 798
Park	81,807	102,339	102,555	106,942	139,464	+ 32,522
Other counties and small mines	2,851	3,098	2,105	7,830	200,289	+ 192,459
Total	1,643,832	1,829,921	2,016,857	1,920,190	2,553,940	+ 633,750
Total value	$2,823,350	$3,240,357	$3,907,082	$3,771,248	$5,036,942	+$1,265,694

The annual production from 1880 to 1909 is shown in the following table:

Production of coal in Montana from 1880 to 1909, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1880	224	1888	41,467	1896	1,543,445	1904	1,358,919
1881	5,000	1889	363,301	1897	1,647,882	1905	1,643,832
1882	10,000	1890	517,477	1898	1,479,803	1906	1,829,921
1883	19,795	1891	541,861	1899	1,496,451	1907	2,016,857
1884	80,376	1892	564,648	1900	1,661,775	1908	1,920,190
1885	86,440	1893	892,309	1901	1,396,081	1909	2,553,940
1886	49,846	1894	927,395	1902	1,560,823		
1887	10,202	1895	1,504,193	1903	1,488,810	Total	29,213,263

NEW MEXICO.

Total production in 1909, 2,801,128 short tons; spot value, $3,619,744.

New Mexico, like Montana, exhibited the effects of the revival in the metal-mining industry in 1909 by a record-making tonnage from the coal mines, the production increasing from 2,467,937 short tons, valued at $3,368,753, in 1908 to 2,801,128 short tons, valued at $3,619,744, in 1909, a gain of 333,191 tons, or 13.5 per cent, in quantity and of $250,991, or 7.5 per cent, in value. Unlike Montana, the value of New Mexico's production increased in less proportion than did the quantity. The increase in tonnage was in the two principal counties of Colfax and McKinley, in which are located, respectively, the Raton and the Gallup fields. The production decreased in all the other counties, a small gain in Lincoln County excepted. The average price per ton declined from $1.37 in 1908 to $1.29 in 1909, which was due to the lower value of the increased production from Colfax County. About 25 per cent of the production of this county is made into coke, the most of which is shipped to interests allied with those producing the coal and making the coke. The placing of a value on the coal charged into the ovens is purely an arbitrary matter, and the decline in price may be more apparent than real.

In 1909, as in 1908, there was an ample supply of cars; there was no interruption to business by labor troubles, and the supply of labor was adequate. More satisfactory than these, however, was the fewer number of accidents notwithstanding the increased tonnage. The United States coal-mining law which governs the mining operations in the Territory of New Mexico does not require the reporting of nonfatal accidents, and the statistics of accidents as compiled by Mr. J. E. Sheridan, territorial mine inspector, include only those that are attended with fatal results. Mr. Sheridan reports that in 1909 there were 13 fatal accidents, a decrease of 10, as compared with 1908. Of these 13 fatalities in 1909, 9 were due to falls of roof or coal. The quantity of coal mined for each life lost in 1909 was 215,471 short tons, against 107,301.6 in 1908, the quantity mined in 1909 being more than double that mined in 1908. During the fifteen years for which the statistics of accidents have been compiled for the Territory the fatal accidents have reached a total of 235. In this period there have only been four years, 1895, 1899, 1901, and 1907, in which there were any deaths due to explosions of either gas or dust. The total number of deaths from explosions in the four years was 43, and 24 of them occurred in 1895, so that in the last fourteen years there have been only 19 deaths due to this cause, while 108 have fallen victims to falls of roof and coal.

The slight difference between the tonnage reported by Mr. McDermott and that reported to the Geological Survey and the Bureau of the Census (a difference of about 12,000 tons), is probably due to the inclusion in the latter report of the production from small local mines which do not come within the purview of the mine-inspection laws.

The statistics of production, by counties, in 1908 and 1909, with the distribution of the product for consumption, are shown in the following table:

Coal production of Montana in 1908 and 1909, by counties, in short tons.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
1908.									
Carbon	811,272	22,165	34,675	....	868,112	$1,689,962	$1.95	226	1,646
Cascade	758,761	24,593	27,891	....	811,245	1,370,948	1.69	214	993
Chouteau	16,500	2,870	400	....	19,770	46,703	2.36	161	43
Fergus	46,600	42,398	1,320	....	90,318	268,826	2.98	199	116
Park	40,160	1,044	6,470	59,268	106,942	343,760	3.21	283	280
Other counties [a]	6,254	6,921	8,773	....	21,948	46,453	2.12	151	68
Small mines	....	1,855	....	....	1,855	4,596	2.48	....	....
Total	1,679,547	101,846	79,529	59,268	1,920,190	3,771,248	1.96	224	3,146
1909.									
Carbon	930,545	26,219	32,900	....	989,664	$2,091,007	$2.11	....	....
Cascade	897,224	24,804	32,629	....	954,657	1,649,036	1.73	....	....
Chouteau	14,622	15,810	1,000	....	31,432	68,207	2.17	....	....
Fergus	196,740	19,991	4,932	....	221,663	457,793	2.07	....	....
Park	39,335	4,329	12,827	82,973	139,464	282,517	2.02	....	....
Other counties [b]	177,695	3,321	28,487	25	209,528	472,325	2.25	....	....
Small mines	....	7,532	....	....	7,532	16,057	2.01	....	....
Total	2,256,161	102,006	112,775	82,998	2,553,940	5,036,942	1.97	....	4,535

[a] Custer, Gallatin, Rosebud, and Valley.
[b] Broadwater, Custer, Gallatin, Granite, Missoula, Rosebud, and Yellowstone.

In the following table is presented a statement of the coal production of Montana, by counties, during the last five years, with increase and decrease in 1909 as compared with 1908:

Production of coal in Montana, 1905–1909, by counties, in short tons.

County.	1905.	1906.	1907.	1908.	1909.	Increase (+) or decrease (−), 1909.
Carbon	588,414	557,148	746,110	868,112	989,664	+ 121,552
Cascade	826,026	1,027,923	1,026,223	811,245	954,657	+ 143,412
Chouteau	6,500	12,305	24,847	19,770	31,432	+ 11,662
Fergus	15,228	29,182	45,760	90,318	221,663	+ 131,345
Gallatin	123,006	97,926	69,257	15,973	16,771	+ 798
Park	81,807	102,339	102,555	106,942	139,464	+ 32,522
Other counties and small mines	2,851	3,098	2,105	7,830	200,289	+ 192,459
Total	1,643,832	1,829,921	2,016,857	1,920,190	2,553,940	+ 633,750
Total value	$2,823,350	$3,240,357	$3,907,082	$3,771,248	$5,036,942	+$1,265,694

The annual production from 1880 to 1909 is shown in the following table:

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1885	86,440	1893	892,309	1901	1,396,081	1909	2,553,940
1886	49,846	1894	927,395	1902	1,560,823		
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New Mexico, like Montana, exhibited the effects of the revival in the metal-mining industry in 1909 by a record-making tonnage from the coal mines, the production increasing from 2,467,937 short tons, valued at $3,368,753, in 1908 to 2,801,128 short tons, valued at $3,619,744, in 1909, a gain of 333,191 tons, or 13.5 per cent, in quantity and of $250,991, or 7.5 per cent, in value. Unlike Montana, the value of New Mexico's production increased in less proportion than did the quantity. The increase in tonnage was in the two principal counties of Colfax and McKinley, in which are located, respectively, the Raton and the Gallup fields. The production decreased in all the other counties, a small gain in Lincoln County excepted. The average price per ton declined from $1.37 in 1908 to $1.29 in 1909, which was due to the lower value of the increased production from Colfax County. About 25 per cent of the production of this county is made into coke, the most of which is shipped to interests allied with those producing the coal and making the coke. The placing of a value on the coal charged into the ovens is purely an arbitrary matter, and the decline in price may be more apparent than real.

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There were employed in the mines of New Mexico in 1909, 4 coal-cutting machines, which produced 1,352 short tons of coal against 30,600 tons mined by 7 machines in 1908, and 11,615 tons mined by 3 machines in 1907.

The statistics of production, by counties, during 1908 and 1909, with the distribution of the product for consumption, are shown in the following table:

Coal production of New Mexico in 1908 and 1909, by counties, in short tons.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
1908.									
Colfax	1,308,309	6,472	16,740	450,114	1,781,635	$2,052,322	$1.15	204	1,995
McKinley	520,367	5,076	13,607	....	539,050	934,089	1.73	162	980
Other counties[a]	125,175	10,115	10,562	....	145,852	379,867	2.60	242	473
Small mines	....	1,400	....	....	1,400	2,475	1.77	....	....
Total	1,953,851	23,063	40,909	450,114	2,467,937	3,368,753	1.37	197	3,448
1909.									
Colfax	1,240,347	19,936	11,276	741,759	2,013,318	$2,196,468	$1.09	....	....
McKinley	647,394	3,913	14,116	....	665,423	1,129,125	1.70	....	....
Other counties[b]	103,974	8,279	7,556	....	119,809	289,735	2.42	....	....
Small mines	....	2,578	....	....	2,578	4,416	1.71	....	....
Total	1,991,715	34,706	32,948	741,759	2,801,128	3,619,744	1.29	....	3,317

[a] Bernalillo, Lincoln, Rio Arriba, Sandoval, San Juan, Santa Fe, and Socorro.
[b] Lincoln, Rio Arriba, San Juan, Santa Fe, and Socorro.

In the following table are presented the statistics of production, by counties, during the last five years, with increase and decrease in 1909, as compared with 1908:

Coal production of New Mexico, 1905–1909, by counties, in short tons.

County.	1905.	1906.	1907.	1908.	1909.	Increase (+) or decrease (−), 1909.
Colfax	1,031,829	1,292,241	1,844,550	1,781,635	2,013,318	+ 231,683
Lincoln	19,143	....	1,691	1,245	1,466	+ 221
McKinley	480,490	560,917	629,821	539,050	665,423	+ 126,373
Rio Arriba	31,700	43,600	34,450	20,000	12,266	− 7,734
Santa Fe	69,832	3,938	31,952	54,740	46,495	− 8,245
Other counties	16,939	64,017	86,495	71,267	62,160	− 9,107
Total	1,649,933	1,964,713	2,628,959	2,467,937	$2,801,128	+ 333,191
Total value	$2,190,231	$2,638,986	$3,832,128	$3,368,753	$3,619,744	+$250,991

The first record of coal production in New Mexico is that contained in the initial issue of the volume, Mineral Resources of the United States, which covered the calendar year 1882. In that year the reported output was 157,092 tons, or about 6 per cent of what it was in 1909, indicating that in twenty-eight years the coal production of New Mexico has increased about 16 times. The annual production since 1882 is given in the following table, which shows that the total production in the period from 1882 to the close of 1909 has amounted to 27,594,497 short tons; this quantity, including mining and other loss, represents a total exhaustion of about 41,400,000 tons.

Production of coal in New Mexico from 1882 to 1909, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1882	157,092	1890	375,777	1898	992,288	1906	1,964,713
1883	211,347	1891	462,328	1899	1,050,714	1907	2,628,959
1884	220,557	1892	661,330	1900	1,299,299	1908	2,467,937
1885	306,202	1893	665,094	1901	1,086,546	1909	2,801,128
1886	271,285	1894	597,196	1902	1,048,763		
1887	508,034	1895	720,654	1903	1,541,781	Total	27,594,497
1888	626,665	1896	622,626	1904	1,452,325		
1889	486,943	1897	716,981	1905	1,649,933		

NORTH CAROLINA.

No coal production was reported from North Carolina in 1906, 1907, 1908, and 1909. The output from the Cumnock mines, which had decreased from 23,000 tons in 1902 to 17,309 tons in 1903 to 7,000 tons in 1904 and to 1,557 tons in 1905, ceased entirely in 1906.

There are two areas in North Carolina in which coal occurs. Both of these are found in the Triassic formation and are of the same geologic age as the Richmond coal basin of Virginia. The two areas are known as the Deep River and the Dan River fields, being named from the two rivers which drain them. The only productive beds in recent years are those in the Deep River district in Chatham and Moore counties.

The following table contains a statement of the production of coal in North Carolina for such years as have been reported:

Distribution of the coal product of North Carolina, 1901–1905, in short tons.

Year.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
1901	10,000		2,000	12,000	$15,000	$1.25	300	25
1902	20,400	100	2,500	23,000	34,500	1.50	285	40
1903	14,429	87	2,793	17,309	25,300	1.47	264	49
1904	4,600	300	2,100	7,000	10,500	1.50	240	25
1905	461	1,096		1,557	2,336	1.50	60	15

The United States census of 1840 stated that a production of 3 tons was obtained from North Carolina in that year. There is no evidence of any other production prior to the Civil War, when the necessities of the Confederate Government were partly relieved by coal obtained from this region. After the war the production fell off for several years, and from 1874 to 1879 none was reported from this area. The Cumnock, or Egypt, mines were reopened in 1889 and were productive each year from that time until 1906.

NORTH DAKOTA.

Total production in 1909, 422,047 short tons; spot value, $645,142.

Substantial progress was made in the utilization of the lignites of North Dakota in 1909, as is shown by an increase in production from 320,742 short tons, valued at $522,116, in 1908 to 422,047 short tons, valued at $645,142, in 1909, a gain of 101,305 tons, or 31.6 per cent, in quantity and of $123,026, or 23.6 per cent, in value.

Extensive beds of lignite underlie the greater part of the western half of the State, and though from a purely calorific point of view lignite is not a high-grade fuel, as it requires special furnaces and large grate areas when used for steam raising and leaves much to be desired when used for domestic heating and cooking, it has been found particularly well adapted as a fuel for use in the manufacture of brick, an industry that is growing rapidly with the increasing population of the State. Brick manufacturers at Dickinson, Scranton, and Kenmare have testified to the efficiency of lignite in this manufacture. According to the statements of these consumers, the use of lignite is specially desirable because of its smokeless and sootless quality in combustion, and its relative low cost as compared with other fuels is also in its favor. One ton of lignite has been found equivalent to one cord of ordinary brickyard wood. The time required for burning a kiln of brick with lignite is from eight days to two weeks, according to the dryness of the bricks when set in the kiln, and also according to the quality of brick required. Some of the brick manufacturers mine the lignite used by them.

With the development of other manufacturing industries in the State, the utilization of lignite for power production through the gas producer will have place. The investigations conducted by the United States Geological Survey at the St. Louis Exposition have shown that lignite is an excellent gas-producer fuel. It yields a higher quality of gas, though less in quantity, than does either anthracite or bituminous coal, and when used for the generation of power in gas engines lignite equals in efficiency the best bituminous coal under boilers.

The number of men employed in the lignite mines of North Dakota increased from 631 in 1908 to 972 in 1909, and the average production per man decreased from 508 to 434 tons, the apparent decrease in efficiency being due in the main to the number of men employed in new development work. There were 16 machines employed for undercutting in 1909, an increase from 11 in 1908. The machine-mined tonnage increased from 104,884 in 1908 to 112,365 in 1909.

According to Mr. T. R. Atkinson, the state mine inspector, there were only two accidents in the lignite mines of North Dakota in 1909, and neither of these was fatal.

The statistics of production, by counties, in 1908 and 1909, with the distribution of the product for consumption, are shown in the following table:

Coal production of North Dakota in 1908 and 1909, by counties, in short tons.

1908.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Burleigh	101,912	10,197	4,848	116,957	$159,697	$1.35	161	201
Morton	4,000	16,800	50	20,850	25,605	1.23	168	45
Stark	26,037	10,430	2,000	38,467	72,987	1.90	177	79
Ward	48,866	61,501	5,413	115,780	219,832	1.90	203	262
Other counties [a]	6,280	17,261	50	23,591	36,913	1.56	164	44
Small mines	....	5,097	....	5,097	7,082	1.39	....	....
Total	187,095	121,286	12,361	320,742	522,116	1.63	181	631

[a] Emmons, McLean, Oliver, and Williams.

Coal production of North Dakota in 1908 and 1909, by counties, in short tons—Continued.

1909.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Burleigh	104,542	11,077	6,803	122,422	$164,521	$1.34	....	....
McLean	1,000	8,250	75	9,325	12,545	1.35	....	....
Morton	2,500	16,134	....	18,634	22,417	1.20	....	....
Stark	60,000	10,550	2,000	72,550	105,690	1.46	....	....
Ward	81,135	56,311	2,550	139,996	248,576	1.78	....	....
Williams	7,811	9,619	1,292	18,722	31,179	1.67	....	....
Other counties[a]	140	17,953	67	18,160	28,321	1.56	....	....
Small mines	....	22,238	....	22,238	31,893	1.43	....	....
Total	257,128	152,132	12,787	422,047	645,142	1.53	....	972

[a] Adams, Bowman, Emmons, Hettinger, and Mercer.

The statistics of production, by counties, during the last five years, with increase and decrease in 1909, as compared with 1908, are shown in the following table:

Coal production of North Dakota, 1905–1909, by counties, in short tons.

County.	1905.	1906.	1907.	1908.	1909.	Increase (+) or decrease (−), 1909.
Burleigh	74,357	83,267	123,662	116,957	122,422	+ 5,465
McLean	15,515	8,005	9,660	7,452	9,325	+ 1,873
Morton	26,100	23,194	10,690	20,850	18,634	− 2,216
Stark	49,417	63,785	71,563	38,467	72,550	+ 34,083
Ward	137,542	120,962	124,214	115,780	139,996	+ 24,216
Williams	9,268	4,431	5,400	13,969	18,722	+ 4,753
Emmons, Mercer	4,000	....	....	....	....	....
Small mines	1,343	[a] 2,045	[a] 2,571	[b] 7,267	[c] 40,398	+ 33,131
Total	317,542	305,689	347,760	320,742	422,047	+ 101,305
Total value	$424,778	$451,382	$560,199	$522,116	$645,142	+$123,026

[a] Includes Emmons County.
[b] Includes Emmons and Oliver counties.
[c] Includes Adams, Bowman, Emmons, Hettinger, and Mercer counties.

The annual production since 1884, as reported to the United States Geological Survey, has been as follows:

Production of coal in North Dakota from 1884 to 1909, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1884	35,000	1891	30,000	1898	83,895	1905	317,542
1885	25,000	1892	40,725	1899	98,809	1906	305,689
1886	25,955	1893	49,630	1900	129,883	1907	347,760
1887	21,470	1894	42,015	1901	166,601	1908	320,742
1888	34,000	1895	38,997	1902	226,511	1909	422,047
1899	28,907	1896	78,050	1903	278,645		
1890	30,000	1897	77,246	1904	271,928	Total	3,527,047

OHIO.

Total production in 1909, 27,939,641 short tons; spot value, $27,789,010.

Although the production of coal in Ohio increased from 26,270,639 short tons in 1908 to 27,939,641 short tons in 1909, the value of the product decreased from $27,897,704 to $27,789,010. The gain in quantity was 1,669,002 tons, or 4.4 per cent, and the decrease in value was $108,694, or 0.4 per cent. The average price per ton declined from $1.06 in 1908 to 99 cents in 1909. The decline in price and the consequent lower value of Ohio's coal in 1909 are attributed to the competition of West Virginia coal. Unhampered by the restrictions that affect the States in which, as in Ohio, the miners are more thoroughly organized, and also because of the more favorable conditions for cheap mining, the coals of West Virginia are said to be mined at about one-half the cost of producing Ohio coal, and the West Virginia product has invaded the Ohio markets to the full extent permitted by the difference in transportation expenses.

Of the 28 counties in the State in which coal was produced on a commercial scale in 1909 (no account being taken of the county distribution of the output from local banks), production increased in 18 and decreased in 10. The most important increases were in Belmont County, 467,796 tons; Jefferson County, 317,102 tons; Tuscarawas, 219,174 tons; Athens, 163,952 tons; Noble, 176,858 tons, and Columbiana, 148,240 tons. The only county which showed any marked decrease was Hocking, whose production fell off 239,141 tons. In no other county was the decrease as much as 100,000 tons.

The most conspicuous feature of the coal-mining industry in Ohio in 1909 was the marked increase in the quantity of coal undercut by machines. Ohio has been for a number of years the leading State in the percentage of the total product mined by machines. In 1909 the machine-mined product amounted to 22,148,216 short tons, or 79.5 per cent of the total. In 1908, 19,799,140 short tons, or 75.37 per cent of the total, was machine-mined. The number of machines in use increased from 1,343 in 1908 to 1,433 in 1909. The average production for each machine was 15,456 tons in 1909 against 14,742 in 1908. In the coal mines of Ohio the chain-breast machines far outnumber all other types. Of the 1,433 machines in use, 1,314 were of the chain-breast type, 97 were punchers, and 22 were long-wall. There were 190 mines in which chain-breast machines were used exclusively. The total number of machines used in these mines was 1,232, and they produced 19,339,022 short tons of coal, an average of 15,697 tons for each machine. Eleven mines employed pick machines exclusively, and the total number of 71 pick machines in these mines produced 364,420 tons, an average for each of 5,133 tons.

Ohio is peculiarly fortunate in not having had any single explosion or other accident which caused the death of a large number of men, notwithstanding it is the fourth among the coal-producing States. From 1884 to 1909, inclusive, a period of twenty-six years, the fatal accidents have numbered 1,823 and the nonfatal accidents 8,411. In the twenty years for which the causes of the accidents have been given there were 1,501 deaths and 6,919 men injured in the coal mines of Ohio. The accidents due to explosions caused 23 deaths, and the largest number killed in any one year was 4. Falls of roof and coal killed 981 and injured 3,487; powder explosions and windy shots killed 97 and injured 351; and 400 deaths and 2,966 injuries were attributed to miscellaneous causes. Mr. George Harrison, state mine inspector, reports 115 fatal and 693 nonfatal accidents in 1909. Only 1 of the fatal accidents was due to the explosion of gas, but 70 were due to falls of roof and coal. According to Mr. Harrison the production in 1909 amounted to 27,756,192 short tons, in the mining of which 47,019 men were employed. The quantity of coal won for each life lost was 241,358 short tons, and the death rate per thousand employees was 2.45. In 1908 there were 232,484 tons mined for each fatality and the death rate was 2.38. The annual report of Mr. Harrison, as stated above, gives the total production of the State for 1909 at 27,756,192 short tons, or about 180,000 tons less than that reported to the Geological Survey and the Bureau of the Census. The difference is negligible, and is easily accounted for in the tonnage from the small local mines. This factor, as reported to the Geological Survey in 1909, amounted to 255,361 short tons.

The statistics of production, by counties, in 1908 and 1909, with the distribution of the product for consumption, are shown in the following table:

Coal production of Ohio in 1908 and 1909, by counties, in short tons.

1908.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Athens	3,829,377	31,730	103,791	2,420	3,967,318	$4,300,692	$1.08	144	7,788
Belmont	5,319,885	208,144	65,748	....	5,593,777	5,204,636	.93	179	8,089
Carroll	314,011	35,587	17,150	....	366,748	363,031	.99	162	650
Columbiana	451,604	38,344	19,097	....	509,045	578,689	1.14	181	1,221
Coshocton	316,395	44,537	3,096	....	364,028	428,774	1.18	200	538
Gallia	7,800	3,650	....	....	11,450	11,735	1.02	156	44
Guernsey	2,852,628	29,306	57,616	....	2,939,550	2,693,031	.92	166	4,670
Harrison	435,006	23,826	5,844	....	464,676	448,129	.96	187	621
Hocking	1,398,402	21,020	14,614	....	1,434,036	1,521,711	1.06	167	2,515
Holmes	2,500	12,509	....	....	15,009	19,988	1.33	166	38
Jackson	750,969	53,058	32,301	....	836,328	1,432,553	1.71	175	2,339
Jefferson	3,241,763	287,427	61,210	616	3,591,016	3,576,394	.99	158	6,288
Lawrence	107,214	60,278	3,815	....	171,307	214,710	1.25	160	510
Mahoning	37,822	28,030	1,460	....	67,312	99,552	1.48	161	152
Medina	1,504	9,345	558	....	11,407	20,546	1.80	199	31
Meigs	385,876	59,203	4,890	....	449,969	480,023	1.07	170	921
Muskingum	369,509	59,097	2,047	....	430,653	406,225	.94	181	803
Noble	189,806	6,252	2,441	....	198,499	188,411	.95	118	395
Perry	2,036,770	63,822	46,403	....	2,146,995	2,366,826	1.10	142	4,297
Stark	372,272	99,564	30,084	....	501,920	957,582	1.91	128	1,310
Summit	82,151	11,110	5,380	....	98,641	184,123	1.87	139	238
Tuscarawas	1,184,480	148,107	25,542	....	1,358,129	1,413,955	1.04	189	2,395
Vinton	128,070	7,795	2,680	....	138,545	147,348	1.06	120	454
Wayne	80,184	9,915	6,332	....	96,431	183,415	1.90	114	328
Other counties [a] and small mines	312,226	142,974	52,650	....	507,850	655,625	1.29	134	772
Total	24,208,224	1,494,630	564,749	3,036	26,270,639	27,897,704	1.06	161	47,407

[a] Morgan, Portage, Scioto, and Trumbull.

drought from June to December, which necessitated in some cases hauling water for the boilers from a distance.

The number of men employed in the Oklahoma coal mines increased from 8,651 in 1908 to 8,689 in 1909. The average production for each man employed increased from 341 short tons to 359 tons. Labor troubles did not interfere in 1909 with the mining operations as they did in 1908 and in 1910.

Unfortunately, the larger part of coal mining in Oklahoma can not properly be classed as coal mining, most of the coal being shot from the solid in spite of all that has been said and written in condemnation of the practice. Shooting from the solid involves less labor than when the coal is undercut even by the use of machines and permitting the practice has reduced the quantity of coal undercut by machines. In 1909 there were only 7 mines in which machines were employed, and the quantity of machine-mined coal was 50,812 short tons, or 1.5 per cent of the total. In 1908, 31,352 tons of coal were machine mined. In 1902, in the then Indian Territory, 119,195 tons were undercut by machines.

In this connection it seems pertinent to call attention to the fact that in the accident statistics for Oklahoma the deaths due to explosion show a percentage larger than the average for other States. In a period of sixteen years 20.12 per cent of the fatalities in the coal mines of Oklahoma (Indian Territory) and in 1909, according to the report of Mr. Peter Hanraty, the state mine inspector, 60 per cent of the deaths were due to this cause. The total number of deaths in 1909 was 40. Twenty-four of these resulted from gas and dust explosions and only 4 were due to falls of roof or coal. Fourteen of the men killed were married and left a total of 60 fatherless children. The death rate per 1,000 was 4.6, and there were 77,984 tons of coal mined for each life lost. There were 107 nonfatal accidents, of which 52 were serious and 55 were minor. In the sixteen years covered by the inspectors' reports there have been 507 men killed and 996 injured.

The year 1908 was the first for which it was possible to give the production of Oklahoma (formerly the Indian Territory) by counties, it having been organized as a State and admitted into the Union in 1906. The statistics of production in 1908 and 1909, by counties, are shown in the following table:

Coal production of Oklahoma in 1908 and 1909, by counties, in short tons.

1908.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Coal	542,634	12,683	21,429	576,746	$1,019,899	$1.77	186	1,832
Haskell and Latimer	619,833	9,915	44,888	674,636	1,332,833	1.98	163	1,789
Le Flore	167,467	6,871	13,286	187,624	297,318	1.58	129	578
Okmulgee	168,674	1,041	3,219	172,934	294,067	1.70	140	439
Pittsburg	1,211,425	13,272	70,239	1,294,936	2,950,029	2.28	180	3,895
Tulsa	37,000	2,298	550	39,848	78,988	1.98	147	118
Small mines	....	1,392	....	1,392	3,370	2.42	....	....
Total	2,747,033	47,472	153,611	2,948,116	5,976,504	2.03	172	8,651

Coal production of Oklahoma in 1908 and 1909, by counties, in short tons—Continued.

1909.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Coal	619,684	12,383	26,092	658,159	$1,313,288	$2.00	....	....
Haskell and Latimer	683,248	5,006	50,552	738,806	1,393,110	1.89	....	....
Le Flore	116,292	3,491	8,593	128,376	179,567	1.40	....	....
Okmulgee	255,937	590	5,783	262,310	437,273	1.67	....	....
Pittsburg	1,153,098	20,657	97,354	1,271,109	2,795,823	2.20	....	....
Rogers and Wagoner	13.956	600	....	14,556	30,729	2.11	....	....
Tulsa	36,899	2,208	727	39,834	90,671	2.28	....	....
Small mines	....	6,227	....	6,227	12,906	2.07	....	....
Total	2,879,114	51,162	189,101	3,119,377	6,253,367	2.00	....	8,689

The production, by counties, with increase and decrease in 1909 as compared with 1908, are shown in the following table:

Coal production of Oklahoma in 1908 and 1909, by counties, in short tons.

County.	1908.	1909.	Increase (+) or decrease (−), 1909.
Coal	576,746	658,159	+ 81,413
Haskell and Latimer	674,636	738,806	+ 64,170
Le Flore	187,624	128,376	− 59,248
Okmulgee	172,934	262,310	+ 89,376
Pittsburg	1,294,936	1,271,109	− 23,827
Rogers and Wagoner	....	14,556	+ 14,556
Tulsa	39,848	39,834	− 14
Small mines	1,392	6,227	+ 4,835
Total	2,948,116	3,119,377	+ 171,261
Total value	$5,976,504	$6,253,367	+$276,863

The statistics of production of coal in Oklahoma (Indian Territory) during the last five years, with the distribution of the product for consumption, are shown in the following table:

Distribution of the coal product of Oklahoma (Indian Territory), 1905–1909, in short tons.

Year.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
1905	2,707,377	38,898	106,547	71,605	2,924,427	$5,145,358	$1.76	188	7,712
1906	2,629,731	38,535	122,299	69,635	2,860,200	5,482,366	1.92	166	8,251
1907	3,381,420	58,882	161,957	40,399	3,642,658	7,433,914	2.04	216	8,398
1908	2,747,033	47,472	153,611	....	2,948,116	5,976,504	2.03	172	8,651
1909	2,879,114	51,162	189,101	....	3,119,377	6,253,367	2.00	....	8,689

The Tenth United States Census (1880) contains the first published record of the production of coal in Oklahoma (Indian Territory), although as a small quantity of coal was mined in Arkansas as early as 1840, it is probable that some was produced in the former Territory earlier than 1880. The maximum production prior to 1907 was obtained in 1903, a total of 3,517,388 short tons, compared with which the production of 1909 shows a decrease of 398,011 tons.

A statement of the production of coal in Oklahoma from 1880 to the close of 1909 is shown in the following table:

Production of coal in Oklahoma from 1880 to 1909, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1880	120,947	1888	761,986	1896	1,366,646	1904	3,046,539
1881	150,000	1889	752,832	1897	1,336,380	1905	2,924,427
1882	200,000	1890	869,229	1898	1,381,466	1906	2,860,200
1883	350,000	1891	1,091,032	1899	1,537,427	1907	3,642,658
1884	425,000	1892	1,192,721	1900	1,922,298	1908	2,948,116
1885	500,000	1893	1,252,110	1901	2,421,781	1909	3,119,377
1886	534,580	1894	969,606	1902	2,820,666		
1887	685,911	1895	1,211,185	1903	3,517,388	Total	45,912,508

OREGON.

Total production in 1909, 87,276 short tons; spot value, $235,085

The production of coal in Oregon in 1909 showed little variation from that of 1908 when the output amounted to 86,259 short tons, valued at $236,021. The difference was a little over a thousand tons in quantity and a little less than $1,000 in value, the former being in favor of 1909 and the latter in favor of 1908. The increase in tonnage was altogether in the production from small mines whose output was used locally. There are only two mines, the Newport and the Beaver Hill, both in Coos County, that ship coal in any quantity, the shipments being made almost entirely by sea to San Francisco. This trade in 1909 was slightly less than in the preceding year, the shipments showing a decrease of 1,139 short tons. There was also a decrease of about 1,000 tons in the colliery consumption, but a gain of something over 3,000 tons in the coal sold to local trade. All of the coal shipped from the Beaver Hill mine is washed, but the refuse from the washery contains sufficient combustible material to permit of its use for fuel at the mines and it is so utilized. This is responsible for the comparatively large quantity of coal appearing as "used at mines for steam and heat." All of the coal mined in the State is lignitic in character, but because of the cheap water transportation to its principal market at San Francisco it is able to compete to some extent in that city with the higher grades of coals from Washington, British Columbia, the Rocky Mountain States, and from Australia.

The coal mines of Oregon were free from labor disturbances in 1909, as in 1908. The only casualties in 1909 were 1 man killed (by gas explosion) and 10 men injured.

The statistics of production in Oregon, with the distribution of the product for consumption during the last five years, are shown in the following table:

Distribution of the coal product in Oregon, 1905–1909, in short tons.

Year.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total quantity.	Total value.	Average price per ton.	Average number of days worked.	Average number of employees.
1905	84,258	7,883	17,500	109,641	$282,495	$2.58	242	316
1906	55,232	7,398	17,101	79,731	212,338	2.66	209	224
1907	39,095	14,840	17,046	70,981	166,304	2.34	231	184
1908	45,375	22,518	18,366	86,259	236,021	2.74	249	214
1909	44,236	25,700	17,340	87,276	235,085	2.69	....	235

Coal was first noted in the Coos Bay region about fifty years ago, Prof. J. S. Newberry having reported in 1855 that the coal deposits of Coos Bay had begun to attract attention. It is known that some mining was done there in 1855 and 1872, and in 1876 two mines, the Eastport and the Newport, were in active operation. The Newport, however, was the only one to survive. The Beaver Hill mine was opened in 1895. This was at first an uncertain factor, but is now one of the important producers. The first record of coal production is contained in the census report of 1880, when 43,205 short tons were mined. The production has exceeded 100,000 tons in four years only—1896, 1897, 1904, and 1905—the maximum being obtained in 1904, when it reached 111,540 tons. The total production to the close of 1909 has amounted to 1,963,927 short tons, as is shown in the following table:

Production of coal in Oregon, 1880–1909, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1880	43,205	1888	75,000	1896	101,721	1904	111,540
1881	33,600	1889	64,359	1897	107,289	1905	109,641
1882	35,000	1890	61,514	1898	58,184	1906	79,731
1883	40,000	1891	51,826	1899	86,888	1907	70,981
1884	45,000	1892	34,661	1900	58,864	1908	86,259
1885	50,000	1893	41,683	1901	69,011	1909	87,276
1886	45,000	1894	47,521	1902	65,648		
1887	37,696	1895	73,685	1903	91,144	Total	1,963,927

PENNSYLVANIA.

Total production in 1909, 219,025,950 short tons; spot value, $279,501,084.

Anthracite.—Total production in 1909, 72,374,249 long tons (equivalent to 81,059,159 short tons); spot value, $149,415,847.

Bituminous.—Total production in 1909, 137,966,791 short tons; spot value, $130,085,237.

Although Pennsylvania still stands preeminent in the production of coal, it no longer contributes more than half of the total output of the United States. Previous to 1902 the combined production of anthracite and bituminous coal in Pennsylvania represented more than 50 per cent of the entire coal production of the country. In that year, however, owing to the prolonged strike in the anthracite region and the resultant loss in tonnage, Pennsylvania's percentage of the total fell to 46, and it has not since regained its high estate, although it reached 49.9 per cent in 1905. In 1909 the total production of coal in the United States was 460,803,416 short tons, of which Pennsylvania's production of 219,025,950 short tons was 47.5 per cent.

Pennsylvania alone produces more coal than any other country in the world, with the exception of Great Britain and Germany. Pennsylvania's production of coal exceeds, in fact, the combined production of all the countries of the world outside of Great Britain, Germany, and Austria-Hungary. The State's output in 1909 was 4.1 times that of Austria-Hungary, 5.2 times the production of France, and 7.9 times the production of Russia, these being, respectively, fourth, fifth, and sixth among the coal-producing countries of the world.

The following table shows the total production of the United States since 1880, with the percentages of the tonnage produced by Pennsylvania in each year:

Production of Pennsylvania coal compared with total production of the United States, 1880–1909, in short tons.

Year.	Total United States.	Pennsylvania.	Percentage of Pennsylvania to total.	Year.	Total United States.	Pennsylvania.	Percentage of Pennsylvania to total.
1880	71,481,570	47,074,975	66	1895	193,117,530	108,216,565	56
1881	85,881,030	54,320,018	63	1896	191,986,357	103,903,534	54
1882	103,285,789	57,254,507	55	1897	200,223,665	107,029,654	53
1883	115,212,125	62,488,190	54	1898	219,976,267	118,547,777	54
1884	119,735,051	62,404,488	52	1899	253,741,192	134,568,180	53
1885	110,957,522	62,137,271	56	1900	269,684,027	137,210,241	51
1886	112,743,403	62,857,210	56	1901	293,299,816	149,777,613	51
1887	129,975,557	70,372,857	54	1902	301,590,439	139,947,962	46
1888	148,659,402	77,719,624	52	1903	357,356,416	177,724,246	49.7
1889	141,229,514	81,719,059	58	1904	351,816,398	171,094,996	49
1890	157,770,963	88,770,814	56	1905	392,722,635	196,073,487	49.9
1891	168,566,668	93,453,921	55	1906	414,157,278	200,575,617	48.4
1892	179,329,071	99,167,080	55	1907	480,363,424	235,747,489	49.1
1893	182,352,774	98,038,267	54	1908	415,842,698	200,448,281	48.2
1894	170,741,526	91,833,584	54	1909	460,803,416	219,025,950	47.5

Compared with 1908, when the total production of the State amounted to 200,448,281 short tons, valued at $276,995,152, the production in 1909 showed an increase of 18,577,669 short tons, or 9 per cent, in quantity and of $2,505,932, or 0.9 per cent, in value. The increase was entirely in the production of bituminous coal. The production of anthracite decreased from 74,347,102 long tons (or 83,268,754 short tons) in 1908 to 72,374,249 long tons (or 81,059,159 short tons) in 1909, with a corresponding decrease in value from $158,178,849 to $149,415,847.

The production of bituminous coal increased from 117,179,527 short tons, valued at $118,816,303, in 1908, to 137,966,791 short tons, valued at $130,085,237, in 1909. The decrease in the production of anthracite was 1,972,853 long tons (2,209,595 short tons), and the value declined $8,763,002. The increase of bituminous coal in 1909 was 20,787,264 short tons in quantity, and $11,268,934 in value.

Inquiries relative to the number of men employed, and the number of days worked, in the coal mines of the United States in 1909 were not included in the joint schedule used for the collection of the coal-mining statistics by the Geological Survey and the Bureau of the Census. It is necessary, therefore, to use the data compiled by Mr. James E. Roderick, chief of the Pennsylvania department of mines. Mr. Roderick reports that 171,195 men were employed in the anthracite mines of Pennsylvania in 1909, and worked an average of 205 days. The bituminous mines employed 185,921 men for 210 days. The average production per man for the year, in the anthracite region, was 423 long tons, or 474 short tons, and 2.31 tons per man per day. In the bituminous mines the average annual production per man was 742 short tons, and the daily production per man 3.53 short tons. In 1908 there were 174,174 men employed in the anthracite mines, and 165,961 men in the bituminous mines. The average annual production per man in 1908 in the anthracite mines was 427 long tons, or 478 short tons, and in the bituminous mines it was 706 short tons. The average daily production per man was, respectively, 2.13 long tons, or 2.39 short tons, of anthracite, and 3.51 short tons of bituminous coal.

Different mine-inspection laws govern the anthracite and the bituminous-coal-mining operations in Pennsylvania, and the statistics of accidents in the two regions are compiled separately. Mining in the anthracite region, as shown by the statistics of accidents, is of a more hazardous character than that in the bituminous mines, although there have been a larger number of men killed by explosions of dust and gas in the bituminous mines than in the anthracite. The statistics of accidents in both the anthracite and the bituminous mines of Pennsylvania are obtained from the excellent records collected by the State department of mines, of which Mr. James E. Roderick is the present chief. From 1885 to 1909, inclusive, a period of twenty-five years, there were 11,589 fatal accidents in the anthracite mines and 6,962 in the bituminous mines. The nonfatal accidents in the bituminous mines have been reported since 1889, and in the twenty-one years 13,935 men were injured. During the same period the injuries received in the anthracite mines were 26,079. Of the 11,589 deaths in the anthracite mines in the twenty-five years since 1885, 876 were due to explosions of gas, a little less than 8 per cent. In the bituminous mines 1,067 deaths out of a total of 6,962 since 1891 were due to explosions of gas or dust. The percentage of deaths in the bituminous mines from this cause was almost exactly double that in the anthracite mines. Falls of roof or coal killed 5,035 men in the anthracite mines during the last twenty-five years and 3,509 men in the bituminous mines during the last nineteen years.

In both the anthracite and the bituminous mines there was a decrease in the fatalities in 1909 as compared with 1908. There was also a decrease in the number of men injured in the anthracite mines, but an increase in the number of injuries received in the bituminous mines. The number of fatalities in the anthracite region in 1909 was 567, as compared with 678 in 1908, and the nonfatal accidents were 1,034 in 1909 and 1,170 in 1908. In the bituminous mines there were 506 men killed in 1909, as compared with 572 in 1908 and 806 in 1907, and the nonfatal accidents in 1909 were 1,126, against 1,019 in 1908. Falls of roof and coal killed 254 men in the anthracite mines in 1909 and 291 men in the bituminous mines. In the same year 48 men were killed in the bituminous mines by dust and gas explosions, and the deaths from gas explosions in the anthracite mines are given at 28. The added danger from dust as an explosive agent is shown by the fact that in the period of twenty-five years 876 men were killed by gas explosions in the anthracite mines, where dust is not a dangerous factor, and the number of men injured from the same cause was 2,972, whereas during a period of seventeen years the explosions in the bituminous mines killed 1,067 and wounded 303. There is little doubt that the comparatively fatal character of the explosions in the bituminous mines is due to the added influence of the dust as an explosive factor. Mr. Roderick reports the number of men employed in the anthracite mines in 1909 as 171,195, and in the bituminous mines as 185,921, from which it appears that the death rate per thousand men employed in the anthracite mines was 3.31 and in the bituminous mines 2.72. The production of anthracite reported to the Geological Survey and the Bureau of the Census was 72,374,249 long tons (equivalent to 81,059,159 short tons), and the bituminous production was reported as 137,966,791 short tons, from which it appears that there were 127,644 long tons, or 142,961 short tons, of anthracite mined for each life lost, while in the bituminous mines the quantity of coal produced for each fatality was 272,661 short tons.

The rapid growth of bituminous-coal production compared with that of anthracite during recent years has been marked and forms one of the most interesting features connected with the statistics of coal mining. Reference has been made to this in previous reports of this series, and the following table has been prepared showing the average production of Pennsylvania anthracite and of bituminous coal throughout the United States, by five-year periods, from 1876 to 1905, and for 1906, 1907, 1908, and 1909, with the percentage each bears to the total. It will be seen from this table that the average production of anthracite during the five years from 1901 to 1905 was 2.59 times the average yearly production from 1876 to 1880, and that the production of anthracite in 1909 was 3.14 times the average annual production from 1876 to 1880. In the bituminous production the tonnage from 1901 to 1905 was 7.5 times that of the output from 1876 to 1880, and the production in 1909 was 10.4 times that of the average for the five years from 1876 to 1880. From 1876 to 1880 the average production of bituminous coal was 1.41 times that of anthracite, but from 1901 to 1905 the production of bituminous coal was 4.08 times that of hard coal. From 1866 to 1870 the production of Pennsylvania anthracite was a little more than half the production of the United States.

The reason for this comparatively large gain in the production of bituminous coal lies in the fact that anthracite has been for a number of years becoming more and more a luxury, and this condition will continue to obtain until the areas are finally exhausted. The comparatively restricted area in which anthracite is produced and the increasing cost of production as deeper and thinner beds have to be worked have resulted naturally in the gradual advance in price and also in the gradual elimination of anthracite as a fuel for manufacturing. It is now almost entirely restricted to domestic consumption in the Eastern States. Large amounts of the smaller sizes of anthracite which were formerly wasted are now used for making steam, sometimes mixed with bituminous coal and sometimes alone, but the smaller sizes are used chiefly for heating and for running elevators in office buildings, hotels, and apartment houses rather than for manufacturing. Even for domestic use coke and gas, the products of bituminous coal, are competing more and more with anthracite in the markets of the larger cities and towns. Under these conditions the statistical situation is not difficult to understand.

The average production of anthracite and bituminous coal, by five-year periods from 1876 to 1905, and for 1906, 1907, 1908, and 1909, is shown in the following table:

Production of anthracite and bituminous coal since 1876, by averages of five-year periods, in short tons.

Period.	Anthracite.		Bituminous.	
	Quantity.	Percentage of total.	Quantity.	Percentage of total.
1876–1880	25,800,169	41.44	36,460,776	58.56
1881–1885	36,198,188	33.74	71,092,930	66.26
1886–1890	43,951,763	31.76	94,446,451	68.24
1891–1895	53,405,187	29.87	125,416,327	70.13
1896–1900	55,625,265	24.49	171,498,143	75.51
1901–1905	66,853,778	19.70	272,503,363	80.30
1906	71,282,411	17.21	342,874,867	82.79
1907	85,604,312	17.82	394,759,112	82.18
1908	83,268,754	20.02	332,573,944	79.98
1909	81,059,159	17.59	379,744,257	82.41

Until 1902 Pennsylvania had enjoyed the distinction of producing more than half the coal output of the United States. From 1889 to 1901, however, the percentage of anthracite production had shown a gradually decreasing tendency, and when the anthracite strike of 1902 caused a decided shrinkage in the production of Pennsylcania anthracite the percentage of the State was reduced to 46. In 1903, notwithstanding the increased production of anthracite and bituminous coal in Pennsylvania in that year, the State's proportion of the total production of the United States was still slightly less than half. In 1904 Pennsylvania produced 49 per cent of the total, and in 1905, with an increase of nearly 25,000,000 tons over the preceding year, the State's proportion of the total production was 49.9 per cent. In 1906 Pennsylvania's percentage again fell off to 48.4 per cent, but with the largely increased production of both anthracite and bituminous coal in 1907, the State's percentage again rose to 49.1. In 1909 Pennsylvania produced 47.5 per cent of the total. It is doubtful if Pennsylvania will in future contribute more than half of the country's total. In 1880 Pennsylvania produced 66 per cent of the entire output of the United States, and during the last twenty-five years has produced about 53 per cent of the total.

Anthracite mining began in Pennsylvania in 1814, when 20 long tons were produced for local consumption. The year 1820 is, however, usually considered to mark the beginning of the anthracite industry, as in that year 365 long tons, 1 for each day of the year, were shipped from the anthracite region. From 1814 to the close of 1909 the total production of anthracite had amounted to 1,871,284,137 long tons, or 2,095,838,234 short tons.

The first records of bituminous-coal production in Pennsylvania are for the year 1840, when 464,826 short tons were mined. The total output of bituminous coal from 1840 to the close of 1909 has amounted to 2,101,215,571 short tons, from which it appears that the total production of anthracite and of bituminous coal in Pennsylvania has been nearly equal. At the close of 1908 the total production of anthracite from the earliest times to the close of that year had exceeded the total bituminous production by approximately 51,000,000 tons. As, however, the production of bituminous coal in 1909 exceeded that of anthracite by more than 56,000,000 short tons, the total production of bituminous coal now exceeds that of anthracite.

PENNSYLVANIA ANTHRACITE.

Since 1896 the report on the production of Pennsylvania anthracite has been prepared by Mr. William W. Ruley, chief of the Bureau of Anthracite Coal Statistics, of Philadelphia. The sudden death of Mr. Ruley in the summer of 1910 has deprived the anthracite industry of a distinguished authority on the statistics and trade conditions and taken from the volumes of Mineral Resources a valued contributor.

The year 1909 showed no striking features in the mining and marketing of anthracite, except an anticipated suspension of operations on April 1, when the three-year wage agreement terminated. The apprehension that a shut down might occur caused unwonted activity at the mines during the first three months of the year, when large quantities of coal were mined and stored. The shipments in March were the largest in the history of the trade. Happily the fears of a struggle were not realized and a new agreement for three years was signed. With a few unimportant changes the new agreement was a second renewal of the awards of the Anthracite Coal Strike Commission, which settled the notable strike of 1902. With the wage scale settled and peace assured, production fell off and the shipments of anthracite in the summer months of 1909 were less than in either 1907 or 1908.

The statistics of production for 1909, as reported to the Geological Survey and the Bureau of the Census, show that the total output of anthracite was 72,374,249 long tons, a decrease as compared with 1908 of 1,972,853 long tons, and as compared with the record year, 1907, of over 4,000,000 long tons. Of the total production in 1909, 62,692,495 long tons were shipped to distant points, 1,961,069 tons were sold to local trade and employees, and 7,720,685 tons, or over 10 per cent of the total, were used in the generation of heat and power for the operation of the mines. The production of 72,374,249 tons included 4,332,873 tons recovered by washeries from the old culm banks and 96,239 tons recovered by dredges from the bed of Susquehanna River. The total output from the mines was 67,945,137 long tons.

As Mr. Ruley stated in the report for 1908, it is, of course, impossible to predict definitely anything in regard to the future of the anthracite industry on account of the competition of other fuels and the possibility of finding improved methods of using them, but it would seem that on account of the limited area and productive capacity of the anthracite measures and the constantly increasing population in the anthracite-consuming territory, the capacity of the mines to supply the demand will be severely taxed and ultimately this territory will become more and more restricted as the ability of the producing companies to supply the increased demand is relatively reduced. In the opinion of many who are familiar with the anthracite industry, the indications are that the maximum of production has about been reached, though there are some who believe that a yearly production of 100,000,000 long tons will be attained before the inevitable period of decline sets in. It must be apparent to all, however, that although anthracite has been regarded as a necessity, it is becoming more and more a luxury and its use will be continued at prices that will not reduce the cost of living.

Different mine-inspection laws govern the anthracite and the bituminous coal-mining operations in Pennsylvania, and the statistics of accidents in the two regions are compiled separately. Statistics of accidents show that mining in the anthracite region is more hazardous than in the bituminous region, although a larger number of men have been killed by explosions of dust and gas in the bituminous mines than in the anthracite mines. From 1885 to 1909, inclusive, a period of twenty-five years, there were 11,491 fatal accidents in the anthracite mines of Pennsylvania. During the same period the nonfatal accidents numbered 23,973. Of the 11,491 deaths occurring in the twenty-five years, 874, but a little less than 8 per cent, were due to explosions of gas. In the bituminous mines, out of a total of 6,366 deaths from 1891 to 1909, inclusive, 1,067 were due to explosions of gas or dust. The percentage of deaths in the bituminous mines from that cause was almost exactly double that in the anthracite mines. Falls of roof killed 5,001 men in the anthracite mines of the State during the last twenty-five years, and 3,909 men in the bituminous mines during the last nineteen years.

In both the anthracite and the bituminous mines of Pennsylvania there was a decrease in the number of fatal accidents in 1909, as compared with 1908. There was also a decrease in the number of men injured in the anthracite mines, but an increase in the number of injuries received in the bituminous mines. The number of fatal accidents in the anthracite region was 567 in 1909, as compared with 678 in 1908. The nonfatal accidents were 1,035 in 1909 and 1,170 in 1908. Falls of roof or coal killed 254 and injured 325 employees in the anthracite mines in 1909, as compared with 284 and 328, respectively, in 1908. Explosions of gas killed 28 and injured 92 in the anthracite mines in 1909; 57 deaths and 130 injuries resulted from the same cause in 1908.

That the comparatively inert character of the dust in the anthracite mines limits the extent of explosions is shown by the fact that whereas 313 men were killed and 239 injured in the bituminous mines of the United States by gas and dust explosions in 1909, the deaths from gas explosions in the anthracite mines were 28 and the injuries 92. There can be little doubt that the relatively fatal character of the explosions in bituminous mines is due to the more explosive nature of bituminous dust.

According to the report of Mr. James E. Roderick, chief of the Department of Mines, there were 171,195 men employed in the anthracite mines of Pennsylvania in 1909, from which it appears that the death rate per 1,000 employees was 3.31. As the production amounted to 72,374,249 long tons (equivalent to 81,059,159 short tons), the coal mined for each life lost was 127,644 long tons (or 142,961 short tons).

In the following table the statistics of anthracite production during the last five years are presented:

Statistics of anthracite production, 1905–1909.

Years.	Quantity (long tons).	Value.	Average price per ton.	Average number of men employed.	Average number of days worked.
1905	69,339,152	$141,879,000	$2.05	165,406	218
1906	63,645,010	131,917,694	2.07	162,355	195
1907	76,432,421	163,584,056	2.14	167,234	220
1908	74,347,102	158,178,849	2.13	174,174	200
1909	72,374,249	149,415,847	2.06	[a]171,195 [b]166,801	205

[a] State Mining Department figures. [b] U. S. Census figures.

The lower price in 1909 was due partly to the slack demand following the wage settlement but for the most part to the increased consumption of the smaller sizes which are elsewhere referred to and which, when forming a portion of the freshly mined coal, are sold at much less than the actual cost of production.

Prior to 1907 no account was taken, in the valuation of the product, of the coal used at the mines for steam and heat, but as every size and even the dust is now a marketable product it has been thought advisable to put an arbitrary value on it. In 1907 and 1908 the colliery consumption was valued at 20 cents a ton. In 1909 it was reported by the operators as of the same value as similar coal put on the market. The production, by counties, in 1908 and 1909, with the distribution of the product for consumption is shown in the following table:

Anthracite production in 1908 and 1909, by counties, in long tons.

Counties.	Shipped.	Sold to local trade and employees.	Used at mines for steam and heat.	Total.
1908.				
Carbon	2,056,630	60,640	259,180	2,376,450
Columbia	911,681	16,428	127,539	1,055,648
Dauphin	553,840	23,366	188,712	765,918
Lackawanna	17,654,782	386,684	1,615,802	19,657,268
Luzerne	24,553,934	669,688	2,753,107	27,976,729
Northumberland	4,609,627	105,067	592,057	5,306,751
Schuylkill	13,935,526	258,286	2,088,154	16,281,966
Sullivan	453,961	6,039	31,710	491,710
Susquehanna	388,994	10,375	35,293	434,662
Total	65,118,975	1,536,573	7,691,554	74,347,102
1909.				
Carbon	1,961,362	77,665	260,872	2,299,899
Columbia	842,685	16,713	118,503	977,901
Dauphin	643,600	23,871	165,022	832,493
Lackawanna	16,396,270	593,772	1,533,918	18,523,960
Luzerne	24,426,413	781,827	2,864,321	28,072,561
Northumberland	4,620,175	106,728	622,632	5,349,535
Schuylkill	12,785,329	260,617	2,073,031	15,118,977
Sullivan	525,644	6,234	39,086	570,964
Susquehanna and Wayne	471,881	8,399	41,440	521,720
River dredges	9,136	85,243	1,860	96,239
Total	62,692,495	1,961,069	7,720,685	72,374,249

The following table shows the shipments, by months, during 1906, 1907, 1908, and 1909, as reported by the bureau of anthracite statistics. The table does not include the shipments from Sullivan County nor the shipments of coal recovered from Susquehanna River:

Monthly shipments of anthracite coal, 1906-1909, in long tons.

Month.	1906	1907	1908	1909
January	5,458,084	5,249,946	5,618,339	5,183,345
February	4,712,099	4,563,720	4,503,756	4,576,004
March	5,797,167	5,235,814	4,766,158	6,332,474
April	488,203	5,916,583	5,987,221	5,891,176
May	3,254,230	5,994,272	6,088,116	5,063,873
June	5,676,018	5,976,906	5,704,852	4,904,858
July	4,981,448	5,669,024	4,541,506	4,020,765
August	5,400,511	5,795,347	4,599,093	4,198,273
September	4,527,886	5,512,717	5,211,047	4,416,120
October	5,384,768	6,108,065	5,977,497	5,579,759
November	5,182,153	5,743,522	5,839,491	6,027,800
December	4,836,028	5,343,477	5,827,938	5,775,438
Total	55,698,595	67,109,393	64,665,014	61,969,885

In connection with the increase in the general production of anthracite, it is interesting to note the rate of increase in the production of domestic sizes and of small or steam sizes. In 1890 the proportion was 76.9 per cent of sizes above pea and 23.1 per cent of pea coal and smaller sizes. In 1900 it was 64.7 and 35.3 per cent, respectively, and in 1909 58.43 and 41.57 per cent, respectively. These figures show a most astonishing change in the relative percentage of the sizes, but it should be borne in mind that a considerable part of this increase in the proportion of small-sized coal is due to the washery product. In 1890 this product amounted to only 41,600 tons, or 0.11 per cent of the total shipments; in 1909 it amounted to 3,694,470 tons, or 5.9 per cent. If the washery product is deducted from the total shipments, the results are as follows:

Shipments of anthracite, excluding washery product, by sizes, 1890, 1908, and 1909, in long tons.

Year.	Sizes above pea.		Pea and smaller.		Total shipments.
	Quantity.	Percentage.	Quantity.	Percentage.	
1890	28,154,678	76.98	8,419,181	23.02	36,573,859
1908	38,280,708	62.74	22,738,056	37.26	61,018,764
1909	36,550,499	61.9	22,438,390	38.1	58,988,889

The figures showing the washery product are not absolutely exact, for the reason that a few washeries are operated at the mines, the small sizes of the freshly mined coal being washed to remove the slate, and no separate report of the coal so washed is made by the mining companies. "Washery coal" as here reported is for the most part that which is recovered from the old culm banks.

To illustrate the change in the proportion of domestic and steam sizes since 1880 the following table is appended:

Shipments of anthracite, according to sizes, 1890–1909, in long tons.

Year.	Sizes above pea.		Pea and smaller.		Total shipments.
	Quantity.	Percentage.	Quantity.	Percentage.	
1890	28,154,678	76.9	8,460,781	23.1	36,615,459
1891	30,604,566	75.7	9,843,770	24.3	40,448,336
1892	31,868,278	76.0	10,025,042	24.0	41,893,320
1893	32,294,233	74.9	10,795,304	25.1	43,089,537
1894	30,482,203	73.7	10,908,997	26.3	41,391,200
1895	32,469,367	69.9	14,042,110	30.1	46,511,477
1896	30,354,797	70.3	12,822,688	29.7	43,177,485
1897	28,510,370	68.5	13,127,494	31.5	41,637,864
1898	28,198,532	67.3	13,701,219	32.7	41,899,751
1899	31,506,700	66.1	16,158,504	33.9	47,665,204
1900	29,162,459	64.7	15,945,025	35.3	45,107,484
1901	34,412,974	64.2	19,155,627	35.8	53,568,601
1902	19,025,632	61.0	12,175,258	39.0	31,200,890
1903	37,738,510	63.6	21,624,321	36.4	59,362,831
1904	35,636,661	62.0	21,855,861	38.0	57,492,522
1905	37,425,217	60.9	23,984,984	39.1	61,410,201
1906	32,894,124	59.1	22,804,471	40.9	55,698,595
1907	39,332,855	58.6	27,776,538	41.4	67,109,393
1908	38,319,325	59.3	26,345,689	40.7	64,665,014
1909	36,626,817	58.4	26,056,542	41.6	62,683,359

It should be noted in connection with the division of sizes that pea coal, which was for years a steam coal, is now used extensively for domestic purposes, and though it is impossible to tell what proportion is so used, the fact that it is no longer an exclusively steam size must be taken into consideration in drawing deductions from the figures presented.

To present statistically the comments made on size division, washery production, etc., the following table, showing washery production since 1890, is given:

Shipments of anthracite from washeries, and total shipments, 1890–1909, in long tons.

Year.	Shipments from washeries.	Total shipments.	Percentage of washery output to total shipments.
1890	41,600	36,615,459	0.11
1891	85,702	40,448,336	.21
1892	90,495	41,893,320	.22
1893	245,175	43,089,537	.57
1894	634,116	41,391,200	1.53
1895	1,080,800	46,511,477	2.52
1896	895,042	43,177,485	2.07
1897	993,603	41,637,864	2.39
1898	1,099,019	41,899,751	2.62
1899	1,368,275	47,665,204	2.87
1900	2,059,349	45,107,484	4.57
1901	2,567,335	53,568,601	4.79
1902	1,959,466	31,200,890	6.28
1903	3,563,269	59,362,831	6.00
1904	2,800,466	57,492,522	4.87
1905	2,644,045	61,410,201	4.31
1906	3,846,501	55,698,595	6.91
1907	4,301,082	67,109,393	6.41
1908	3,646,250	64,665,014	5.64
1909	3,694,470	62,683,359	5.89

The following table shows the quantities of the different sizes of freshly mined coal and of washery coal shipped in 1909:

Shipments, by sizes, from mines and washeries in 1909, in long tons.

Size.	From mines.	From washeries.
Lump and steamboat	791,523	....
Broken	3,438,558	....
Egg	7,782,351	606
Stove	11,642,443	9,449
Chestnut	12,895,624	66,263
Pea	7,410,758	240,910
Buckwheat No 1	8,287,460	855,933
Buckwheat No 2 and rice	4,283,417	1,336,466
Buckwheat No. 3	2,145,938	1,172,831
Screenings	310,817	12,012
Total	58,988,889	3,694,470

As shown by the preceding table, the stove and chestnut sizes are in the greatest demand and make up over 40 per cent of the total shipments. They are essentially domestic sizes and the relatively large proportion they make of the shipments serves as an index to the conditions governing the anthracite trade. Egg coal finds its way principally to the furnaces of residences and pea coal is used in the same way to some extent, though it is also used for kitchen ranges and some of it goes with the buckwheat, etc., for use as steam coal. The small sizes come directly into competition with bituminous and sometimes are used mixed with bituminous coal for steam purposes, chiefly in hotels, apartment houses, and office buildings. If egg and chestnut are considered as domestic coals, the shipments of domestic sizes in 1909 aggregated nearly 40,000,000 tons of the practically 59,000,000 tons of mine coal shipped during the year.

In the following table is presented a statement showing the quantity and percentage of each size shipped from each county in 1909. This is the first time that a compilation of this character has been given in these reports:

Quantity and percentage of each size of anthracite shipped from each county in 1909, in long tons.

Counties.	Lump and steamboat.		Broken.		Egg.		Stove.	
	Quantity.	Per cent.	Quantity.	Per cent.	Quantity.	Per cent.	Quantity.	Per cent.
Carbon	68,276	8.63	185,346	5.39	217,087	2.79	279,688	2.40
Columbia	51,129	6.46	67,621	1.97	125,255	1.61	137,705	1.18
Dauphin	....	....	26,549	.77	42,974	.55	88,934	.76
Lackawanna	72,216	9.12	657,015	19.11	2,052,505	26.37	3,242,653	27.83
Luzerne	197,443	24.94	1,348,921	39.23	3,228,754	41.49	4,826,735	41.43
Northumberland	41,800	5.28	142,177	4.13	468,028	6.01	952,304	8.17
Schuylkill	338,909	42.82	955,239	27.78	1,516,213	19.48	1,928,765	16.55
Sullivan	....	....	10,341	.30	52,101	.67	69,386	.60
Susquehanna and Wayne	21,750	2.75	45,349	1.32	80,040	1.03	125,722	1.08
Total	791,523	100.00	3,438,558	100.00	7,782,957	100.00	11,651,892	100.00

Quantity and percentage of each size of anthracite shipped from each county in 1909, in long tons—Continued.

Counties.	Chestnut.		Pea.		Buckwheat No. 1.		Buckwheat No. 2 and rice.	
	Quantity.	Per cent.	Quantity.	Per cent.	Quantity.	Per cent.	Quantity.	Per cent.
Carbon	318,910	2.46	268,792	3.51	281,893	3.08	222,679	3.96
Columbia	155,162	1.20	119,287	1.56	123,177	1.35	60,859	1.08
Dauphin	106,407	.82	70,775	.93	160,773	1.76	126,642	2.25
Lackawanna	3,374,727	26.04	1,917,208	25.06	2,053,985	22.46	1,610,758	28.66
Luzerne	5,707,896	44.04	2,735,081	35.74	3,362,755	36.78	1,730,902	30.80
Northumberland	965,011	7.44	626,139	8.18	858,162	9.39	524,535	9.34
Schuylkill	2,165,742	16.71	1,757,595	22.97	2,297,650	25.13	1,305,796	23.24
Sullivan	101,418	.78	67,095	.88				
Susquehanna and Wayne	66,614	.51	89,696	1.17	4,998	.05	37,712	.67
Total	12,961,887	100 00	7,651,668	100.00	9,143,393	100.00	5,619,883	100.00

Counties.	Buckwheat No. 3.		Screenings.		Total.	
	Quantity.	Per cent.	Quantity.	Per cent.	Quantity.	Per cent.
Carbon	118,691	3.58			1,961,362	3.13
Columbia	2,490	.08			842,685	1.34
Dauphin	11,327	.34	9,219	2.85	643,600	1.03
Lackawanna	1,403,970	42.30	11,233	3.48	16,396,270	26.16
Luzerne	1,260,957	37.99	36,969	11.45	24,436,413	38.98
Northumberland	41,676	1.26	343	.11	4,620,175	7.37
Schuylkill	479,658	14.45	39,762	12.32	12,785,329	20.40
Sullivan			225,303	69.79	525,644	.84
Susquehanna and Wayne					471,881	.75
Total	3,318,769	100.00	322,829	100.00	62,683,359	100.00

The following table gives the yearly shipments of anthracite as reported by the Bureau of Anthracite Statistics, from the earliest date to the close of 1909, divided according to the three trade regions. These shipments include only coal loaded on cars for line or tide points and do not include any coal sold locally or used at and about the mines, nor the shipments from the Sullivan County mines:

Annual shipments from the Schuylkill, Lehigh, and Wyoming regions, 1820–1909, in long tons.

Year.	Schuylkill region.		Lehigh region.		Wyoming region.		Total.
	Quantity.	Per centage.	Quantity.	Percentage.	Quantity.	Percentage.	Quantity.
1820			365				365
1821			1,073				1,073
1822	1,480	39.79	2,240	60.21			3,720
1823	1,128	16.23	5,823	83.77			6,951
1824	1,567	14.10	9,541	85.90			11,108
1825	6,500	18.60	28,393	81.40			34,893
1826	16,767	34.90	31,280	65.10			48,047
1827	31,360	49.44	32,074	50.56			63,434
1828	47,284	61.00	30,232	39.00			77,516
1829	79,973	71.35	25,110	22.40	7,000	6.25	112,083
1830	89,984	51.50	41,750	23.90	43,000	24.60	174,734

Annual shipments from the Schuylkill, Lehigh, and Wyoming regions, 1820–1909, in long tons—Continued.

Year.	Schuylkill region.		Lehigh region.		Wyoming region.		Total.
	Quantity.	Percentage.	Quantity.	Percentage.	Quantity.	Percentage.	Quantity.
1831	81,854	46.29	40,966	23.17	54,000	30.54	176,820
1832	209,271	57.61	70,000	19.27	84,000	23.12	363,271
1833	252,971	51.87	123,001	25.22	111,777	22.91	487,749
1834	226,692	60.19	106,244	28.21	43,700	11.60	376,636
1835	339,508	60.54	131,250	23.41	90,000	16.05	560,758
1836	432,045	63.16	148,211	21.66	103,861	15.18	684,117
1837	530,152	60.98	223,902	25.75	115,387	13.27	869,441
1838	446,875	60.49	213,615	28.92	78,207	10.59	738,697
1839	475,077	58.05	221,025	27.01	122,300	14.94	818,402
1840	490,596	56.75	225,313	26.07	148,470	17.18	864,379
1841	624,466	65.07	143,037	14.90	192,270	20.03	959,773
1842	583,273	52.62	272,540	24.59	252,599	22.79	1,108,412
1843	710,200	56.21	267,793	21.19	285,605	22.60	1,263,598
1844	887,937	54.45	377,002	23.12	365,911	22.43	1,630,850
1845	1,131,724	56.22	429,453	21.33	451,836	22.45	2,013,013
1846	1,308,500	55.82	517,116	22.07	518,389	22.11	2,344,005
1847	1,665,735	57.79	633,507	21.98	583,067	20.23	2,882,309
1848	1,733,721	56.12	670,321	21.70	685,196	22.18	3,089,238
1849	1,728,500	53.30	781,556	24.10	732,910	22.60	3,242,966
1850	1,840,620	54.80	690,456	20.56	827,823	24.64	3,358,899
1851	2,328,525	52.34	964,224	21.68	1,156,167	25.98	4,448,916
1852	2,636,835	52.81	1,072,136	21.47	1,284,500	25.72	4,993,471
1853	2,665,110	51.30	1,054,309	20.29	1,475,732	28.41	5,195,151
1854	3,191,670	53.14	1,207,186	20.13	1,603,478	26.73	6,002,334
1855	3,552,943	53.77	1,284,113	19.43	1,771,511	26.80	6,608,567
1856	3,603,029	52.91	1,351,970	19.52	1,972,581	28.47	6,927,580
1857	3,373,797	50.77	1,318,541	19.84	1,952,603	29.39	6,644,941
1858	3,273,245	47.86	1,380,030	20.18	2,186,094	31.96	6,839,369
1859	3,448,708	44.16	1,628,311	20.86	2,731,236	34.98	7,808,255
1860	3,749,632	44.04	1,821,674	21.40	2,941,817	34.56	8,513,123
1861	3,160,747	39.74	1,738,377	21.85	3,055,140	38.41	7,954,264
1862	3,372,583	42.86	1,351,054	17.17	3,145,770	39.97	7,869,407
1863	3,911,683	40.90	1,894,713	19.80	3,759,610	39.30	9,566,006
1864	4,161,970	40.89	2,054,669	20.19	3,960,836	38.92	10,177,475
1865	4,356,959	45.14	2,040,913	21.14	3,254,519	33.72	9,652,391
1866	5,787,902	45.56	2,179,364	17.15	4,736,616	37.29	12,703,882
1867	5,161,671	39.74	2,502,054	19.27	5,325,000	40.99	12,988,725
1868	5,330,737	38.52	2,502,582	18.13	5,968,146	43.25	13,801,465
1869	5,775,138	41.66	1,949,673	14.06	6,141,369	44.28	13,866,180
1870	4,968,157	30.70	3,239,374	20.02	7,974,660	49.28	16,182,191
1871	6,552,772	41.74	2,235,707	14.24	6,911,242	44.02	15,699,721
1872	6,694,890	34.03	3,873,339	19.70	9,101,549	46.27	19,669,778
1873	7,212,601	33.97	3,705,596	17.46	10,309,755	48.57	21,227,952
1874	6,866,877	34.09	3,773,836	18.73	9,504,408	47.18	20,145,121
1875	6,281,712	31.87	2,834,605	14.38	10,596,155	53.75	19,712,472
1876	6,221,934	33.63	3,854,919	20.84	8,424,158	45.53	18,501,011
1877	8,195,042	39.35	4,332,760	20.80	8,300,377	39.85	20,828,179
1878	6,282,226	35.68	3,237,449	18.40	8,085,587	45.92	17,605,262
1879	8,960,829	34.28	4,595,567	17.58	12,586,293	48.14	26,142,689
1880	7,554,742	32.23	4,463,221	19.05	11,419,279	48.72	23,437,242
1881	9,253,958	32.46	5,294,676	18.58	13,951,383	48.96	28,500,017
1882	9,459,288	32.48	5,689,437	19.54	13,971,371	47.98	29,120,096
1883	10,074,726	31.69	6,113,809	19.23	15,604,492	49.08	31,793,027
1884	9,478,314	30.85	5,562,226	18.11	15,677,753	51.04	30,718,293
1885	9,488,426	30.01	5,898,634	18.65	16,236,470	51.34	31,623,530
1886	9,381,407	29.19	5,723,129	17.89	17,031,826	52.82	32,136,362
1887	10,609,028	30.63	4,347,061	12.55	19,684,929	56.82	34,641,018
1888	10,654,116	27.93	5,639,236	14.78	21,852,366	57.29	38,145,718
1889	10,486,185	29.28	6,294,073	17.57	19,036,835	53.15	35,817,093
1890	10,867,822	29.68	6,329,658	17.28	19,417,979	53.04	36,615,459
1891	12,741,258	31.50	6,381,838	15.78	21,325,240	52.72	40,448,336
1892	12,626,784	30.14	6,451,076	15.40	22,815,480	54.46	41,893,340
1893	12,357,444	28.68	6,892,352	15.99	23,839,741	55.33	43,089,537
1894	12,035,005	29.08	6,705,434	16.20	22,650,761	54.72	41,391,200
1895	14,269,932	30.68	7,298,124	15.69	24,943,421	56.63	46,511,477

Annual shipments from the Schuylkill, Lehigh, and Wyoming regions, 1820–1909, in long tons—Continued.

Year.	Schuylkill region.		Lehigh region.		Wyoming region.		Total.
	Quantity.	Percentage.	Quantity.	Percentage.	Quantity.	Percentage.	Quantity.
1896	13,097,571	30.34	6,490,441	15.03	23,589,473	54.63	43,177,485
1897	12,181,061	29.26	6,249,540	15.00	23,207,263	55.74	41,637,864
1898	12,078,875	28.83	6,253,109	14.92	23,567,767	56.25	41,899,751
1899	14,199,009	29.79	6,887,909	14.45	26,578,286	55.76	47,665,204
1900	13,502,732	29.94	6,918,627	15.33	24,686,125	54.73	45,107,484
1901	16,019,591	29.92	7,211,974	13.45	30,337,036	56.63	53,568,601
1902	8,471,391	27.15	3,470,736	11.12	19,258,763	61.73	31,200,890
1903	16,474,790	27.75	7,164,783	12.07	35,723,258	60.18	59,362,831
1904	16,379,293	28.49	7,107,220	12.36	34,006,009	59.15	57,492,522
1905	17,703,099	28.83	7,849,205	12.78	35,857,897	58.39	61,410,201
1906	16,011,285	28.75	7,046,617	12.65	32,640,693	58.60	55,698,595
1907	20,141,288	30.01	8,329,653	12.41	38,638,452	57.58	67,109,393
1908	18,006,464	27.85	7,786,255	12.04	38,872,295	60.11	64,665,014
1909	16,864,147	27.21	7,532,271	12.16	37,573,467	60.63	61,969,885
	539,524,715	32.03	264,855,558	15.72	880,110,327	52.25	1,684,490,600

A tabular statement of the several sections of the anthracite fields is given below:

Anthracite coal fields, by field, local district, and trade region.

Coal field or basin.	Local district.	Trade region.
Northern	Carbondale	Wyoming.
	Scranton	
	Pittston	
	Wilkes-Barre	
	Plymouth	
	Kingston	
Eastern middle	Green Mountain	Lehigh.
	Black Creek	
	Hazleton	
	Beaver Meadow	
	Panther Creek	
Southern	East Schuylkill	Schuylkill.
	West Schuylkill	
	Lorberry	
	Lykens Valley	
Western middle	East Mahanoy	
	West Mahanoy	
	Shamokin	

The above-named fields comprise an area of somewhat more than 480 square miles and are located in the eastern-middle part of the State, in the counties of Carbon, Columbia, Lackawanna, Luzerne, Northumberland, Schuylkill, and Susquehanna. They are classed under three general regions—the Wyoming, the Lehigh, and the Schuylkill regions, which are geologically divided into fields or basins and subdivided into districts.

The Bernice field, in Sullivan County, is not included in any of these regions. The classification of the product of this field is a matter of much contention. The fracture of the coal and some of its physical characteristics are more like some bituminous or semi-anthracite coals than strict anthracite, but on account of its high percentage of fixed carbon and low percentage of moisture it is classed as anthracite by the Second Pennsylvania Geological Survey, and it is therefore included in this report.

The anthracite fields are reached by ten so-called initial railroads, as follows:

Philadelphia and Reading Railway Company.
Lehigh Valley Railroad Company.
Central Railroad of New Jersey.
Delaware, Lackawanna and Western Railroad Company.
Delaware and Hudson Company's Railroad.
Pennsylvania Railroad Company.
Erie Railroad Company.
New York, Ontario and Western Railroad Company.
Delaware, Susquehanna and Schuylkill Railroad Company (part of Lehigh Valley system).
New York, Susquehanna and Western Railroad Company (part of Erie system).

PENNSYLVANIA BITUMINOUS COAL.

Total production in 1909, 137,966,791 short tons; spot value, $130,085,237.

In the production of bituminous-coal Pennsylvania's record for 1909 was an increase of more than 20,750,000 tons over the output of 1908. The increase in production was attended, however, with a considerable reduction in prices. In 1908 the production of bituminous coal in Pennsylvania was 117,179,527 short tons, valued at $118,816,303; in 1909 it amounted to 137,966,791 short tons, valued at $130,085,237. The output in 1909 exceeded that of 1908 by 20,787,264 short tons, or 17.7 per cent in quantity, and $11,268,934, or 9.5 per cent, in value. The average price per ton declined from $1.01 to 94 cents, the year 1909 being the first since 1905 that the average price for bituminous coal in Pennsylvania has fallen below $1. The production in 1909, notwithstanding the increase over 1908, was more than 12,000,000 tons short of the maximum record of 150,143,177 tons made in 1907. The average price per ton in 1909 was 10 cents less than it was in 1907.

As in 1908, the principal decreases were in the "Connellsville coke" producing counties of Fayette and Westmoreland, so in 1909 the largest recoveries in tonnage were in these two counties, but at a considerable sacrifice in price. Fayette County's production increased 9,391,812 short tons, from 19,474,417 tons in 1908 to 28,866,229 short tons in 1909, and attained within 400,000 tons of the record output of 1907. The average price per ton for the county declined from $1.04 in 1907 and $1.01 in 1908 to 83 cents in 1909. Westmoreland County increased 3,933,028 short tons, from 21,499,292 short tons in 1908 to 25,432,320 short tons in 1909, and the average price declined from 99 cents in 1907 to 97 cents in 1908 and to 87 cents in 1909. The production of these two counties combined amounted in 1909 to more than 10 per cent of the total production of the United States in 1909 and exceeded the production of any other coal-producing State. The coal production of Illinois in 1909 was 50,904,990 short tons, and West Virginia exceeded this by about 700,000 tons; but the united output of Fayette and Westmoreland counties was 54,298,549 short tons.

The increase in quantity and the decline in price were general throughout the larger coal-producing counties, an exception as to price being noted for Cambria County, whose percentage of increase was the same for both quantity and value. Allegheny County gained 2,003,167 short tons, and the average price declined from $1.05 to $1; Cambria County gained 1,406,877 tons, with no change in price; Clearfield County gained 1,325,788 tons, and the price

Annual shipments from the Schuylkill, Lehigh, and Wyoming regions, 1820–1909, in long tons—Continued.

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Western middle	East Mahanoy West Mahanoy Shamokin	Schuylkill.

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In the production of bituminous coal alone Pennsylvania far outranks all the other coal-producing States, the output in 1909 having been more than two and one-half times that of West Virginia, which for the second time in its history held second place, and having exceeded the combined production of West Virginia, Illinois, and Ohio, the second, third, and fourth States, respectively, by over 7,000,000 tons.

There was less complaint of car shortage in the bituminous districts of Pennsylvania in 1909 than there had been for several years preceding the business depression of 1908, the transportation companies having had in that lean year an opportunity to catch up somewhat in this respect. There was some shortage of labor, as many of the foreign miners had taken advantage of the business depression in 1908 to visit their native countries and some had not returned to their working places. On the whole, however, labor conditions were fairly satisfactory. Some strikes occurred, but they were not of a general character. Altogether there were 5,824 men on strike at one time or another, the total time lost being 260,381 working days, or an average of 45 days for each man on strike. As, according to the report of the State department of mines, there were 185,921 men employed for an average of 210 days, it can readily be seen that the labor troubles were not sufficient to affect the production materially. Several strikes occurred in the mines of the Monongahela River Consolidated Coal and Coke Company, in Allegheny, Fayette, and Washington counties, the number of men idle, the duration of the strikes, and the causes of the troubles being reported by that company as follows: At the Gallatin mine 253 men idle for 46 days, at the Sunnyside mine 235 men idle for 27 days; cause, objectionable colonies of Italians. The refusal of miners to use safety explosives as recommended by the State department of mines caused the idleness of 236 men for 116 days at the Cincinnati mine, 266 men for 6 days at the Albany mine, 304 men for 5 days at the Crowthers mine, and 267 men for 59 days at the Monongah mine. A misunderstanding of the wage agreement laid 285 men idle for 32 days at the Little Redstone mine; trouble over a check weighman put 366 men out of employment for 64 days at the Black Diamond mine; and difficulty about securing releases from parents of minors shut down for 38 days the Tremont mine employing 325 men.

The number of mining machines in use in the bituminous mines of Pennsylvania increased from 5,103 in 1908 to 5,616 in 1909, and the machine-mined product increased from 52,447,809 short tons to 57,504,188 short tons. The machine-mined product in 1909 represented 41.68 per cent of the total output, against 44.76 per cent in 1908. Of the 5,616 machines in use in 1909, 3,847 were punchers, 1,710 were chain-breast, 38 were long-wall, and 21 were chain-shearing machines. There were 167 mines in which punching machines were exclusively used and 145 mines in which only chain-breast machines were used. In the mines using punchers exclusively the number of machines was 3,132 and the machine-mined product was

22,741,280 short tons, or an average of 7,261 tons for each machine. The exclusively chain-machine mines employed 1,265 machines in the production of 24,016,842 short tons, an average of 18,986 tons to each machine. In making these comparisons, however, it should be remembered that a large number of the punching machines are used in entry and other narrow work, to which the chain machine is not adapted and in which the tonnage won is much less than in the straight room mining.

According to the report of Mr. James E. Roderick, chief of the Pennsylvania department of mines, there were 506 men killed and 1,126 injured in the bituminous mines of the State in 1909. As in 1908, there were, fortunately, no explosion horrors involving the deaths of large numbers of men, only 48 men being killed in this way in 1909 against 162 in 1908 and 276 in 1907. There was, however, an increase from 263 in 1908 to 291 in 1909 in the number of men killed by falls of roof or coal. There was also an increase from 557 to 590 in the number of men injured from this cause. Of the 506 men killed 270 were married and left 613 children. Mr. Roderick reports the number of men employed in the bituminous mines of Pennsylvania in 1909 at 185,921, from which it appears that the death rate per thousand of employees was 2.72. There were 272,661 tons of coal mined for each life lost.

Considering the large production of bituminous coal in Pennsylvania, the quantity of coal washed is relatively insignificant, and most of that which is washed is slack coal used in the manufacture of coke. In 1909 there were 3,224,461 short tons of coal washed. This yielded 2,985,512 tons of cleaned coal and 238,949 tons of refuse.

The statistics of production, by counties, with the distribution of the product for consumption in 1908 and 1909, are shown in the following table:

Bituminous coal production of Pennsylvania in 1908 and 1909, by counties, in short tons.

1908.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Allegheny	13,551,805	302,056	229,982	....	14,083,843	$14,843,665	$1.05	189	22,384
Armstrong	2,611,071	80,149	86,266	....	2,777,486	2,736,542	.99	188	4,552
Beaver	142,605	77,682	2,424	....	222,711	261,537	1.17	211	309
Bedford	412,023	5,050	9,559	84,382	511,014	519,219	1.02	146	1,099
Blair	258,249	2,621	5,957	48,340	315,167	337,871	1.07	180	554
Butler	772,343	13,838	16,281	....	802,462	808,205	1.01	207	1,339
Cambria	12,354,638	209,275	320,313	1,254,082	14,138,308	14,792,377	1.05	213	22,804
Center	1,058.824	24,562	2,998	....	1,086,384	1,021,227	.94	187	1,757
Clarion	937,310	10,845	24,630	....	972,785	967,940	1.00	190	1,882
Clearfield	5,783,688	79,552	164,355	219.939	6,247,534	6,049,552	.97	171	11,376
Elk	1,050,095	32,168	22,029	42,917	1,147,209	1,265,208	1.17	201	2,056
Fayette	5,798,619	266,951	487,870	12,920,977	19,474,417	19,707,839	1.01	214	19,866
Huntingdon	528,095	10,724	12,851	46,424	598,094	670,525	1.12	195	1,264
Indiana	6,441,351	28,587	175,120	198,121	6,843,179	6,359,687	.93	200	10,311
Jefferson	3,767,418	33,742	108,257	943,896	4,853,313	4,695,603	.97	170	6,202
Lawrence	117,808	13,637	11,194	....	142,639	168,371	1.18	126	355
Mercer	681,421	4,977	37,760	....	724,158	763,471	1.05	201	1,408
Somerset	7,150,123	53,878	198,101	2,843	7,404,945	7,848,656	1.06	236	10,244
Tioga	643,285	31,182	7,632	....	682,099	1,022,913	1.50	133	2,050
Washington	11.309,761	96,202	313,387	398,657	12,118,007	12,470,171	1.03	196	17,364
Westmoreland	15,555,657	330,457	572,765	5,040,413	21,499,292	20,915,077	.97	214	26,041
Other counties [a] and small mines	433,818	93,157	7,506	....	534,481	590,647	1.11	229	744
Total	91,360,007	1,801,292	2,817,237	21,200,991	117,179,527	118,816,303	1.01	201	165,961

[a] Bradford, Clinton, Greene, and Lycoming.

Bituminous coal production of Pennsylvania in 1908 and 1909, by counties, in short tons—Continued.

1909.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Allegheny	15,270,642	527,809	288,559		16,087,010	$16,122,538	$1.00		
Armstrong	2,588,538	115,752	83,218		2,787,508	2,639,543	.95		
Beaver	173,322	49,538	1,590		224,450	271,585	1.21		
Bedford	301,572	12,165	8,973	112,419	435,129	454,295	1.04		
Blair	329,680	664	7,395	72,422	410,161	438,698	1.07		
Butler	791,335	16,380	20,328		828,043	846,395	1.02		
Cambria	13,240,128	366,051	331,205	1,607,801	15,545,185	16,399,502	1.05		
Center	1,207,489	30,586	974		1,239,049	1,188,764	.96		
Clarion	915,514	3,185	22,360		941,059	924,568	.98		
Clearfield	6,817,013	215,329	178,826	362,154	7,573,322	7,192,429	.95		
Elk	1,077,291	20,415	18,811	34,158	1,150,675	1,086,782	.94		
Fayette	7,066,334	304,920	547,481	20,947,494	28,866,229	24,002,056	.83		
Huntingdon	471,734	5,877	8,449	16,763	502,823	561,555	1.12		
Indiana	7,367,630	36,452	154,632	122,491	7,681,205	7,026,668	.91		
Jefferson	3,885,172	51,023	137,979	860,733	4,934,907	4,129,201	.82		
Lawrence	140,495	4,552	11,702		156,749	202,911	1.29		
Mercer	783,431	68,260	42,189		893,880	999,624	1.10		
Somerset	7,624,276	64,162	186,541	27,359	7,902,338	8,614,082	1.09		
Tioga	741,462	36,774	7,686		785,922	1,219,560	1.55		
Washington	12,072,069	99,253	317,482	493,375	12,982,179	12,985,584	1.00		
Westmoreland	15,505,326	356,760	582,225	8,988,009	25,432,320	22,048,281	.87		
Other counties[a] and small mines	427,202	172,385	7,061		606,648	730,616	1.20		
Total	98,797,655	2,558,292	2,965,666	33,645,178	137,966,791	130,085,237	.94	210	185,921

[a] Bradford, Cameron, Clinton, Greene, and Lycoming.

The statistics of production by counties during the last five years, with increase and decrease in 1909 as compared with 1908, are shown in the following table:

Bituminous coal production of Pennsylvania, 1905–1909, by counties, in short tons.

County.	1905.	1906.	1907.	1908.	1909.	Increase (+) or decrease (−), 1909.
Allegheny	13,662,610	16,823,027	18,315,736	14,083,843	16,087,010	+ 2,003,167
Armstrong	2,497,314	2,574,758	3,430,002	2,777,486	2,787,508	+ 10,022
Beaver	82,676	81,531	109,575	222,711	224,450	+ 1,739
Bedford	752,715	734,855	967,313	511,014	435,129	− 75,885
Blair	348,749	402,438	493,219	315,167	410,161	+ 94,994
Butler	550,589	803,499	902,729	802,462	828,043	+ 25,581
Cambria	12,600,891	12,439,152	16,361,880	14,138,308	15,545,185	+ 1,406,877
Center	810,441	895,434	1,256,383	1,086,384	1,239,049	+ 152,665
Clarion	714,478	719,548	1,078,367	972,785	941,059	− 31,726
Clearfield	7,248,305	5,944,745	8,034,711	6,247,534	7,573,322	+ 1,325,788
Clinton	296,988	233,674	322,624	253,958	272,184	+ 18,226
Elk	1,249,337	944,367	1,427,841	1,147,209	1,150,675	+ 3,466
Fayette	24,250,989	27,044,451	29,260,622	19,474,417	28,866,229	+ 9,391,812
Greene	105,000	144,251	158,187	145,644	137,448	− 8,196
Huntingdon	559,039	630,155	721,604	598,094	502,823	− 95,271
Indiana	4,477,431	4,657,457	7,635,998	6,843,179	7,681,205	+ 838,026
Jefferson	6,393,985	5,160,195	5,964,397	4,853,313	4,934,907	+ 81,594
Lawrence	267,470	257,716	220,718	142,639	156,749	+ 14,110
Lycoming	33,844	44,425	51,956	34,626	28,016	− 6,610
Mercer	707,964	842,648	955,290	724,158	893,880	+ 169,722
Somerset	6,412,672	6,674,191	7,769,708	7,404,945	7,902,338	+ 497,393
Tioga	706,723	826,925	1,146,353	682,099	785,922	+ 103,823
Washington	10,609,051	12,714,405	14,535,727	12,118,007	12,982,179	+ 864,172
Westmoreland	22,998,726	27,573,420	28,916,721	21,499,292	25,432,320	+ 3,933,028
Small mines	[a] 75,650	[a] 125,939	[b] 105,516	[c] 100,253	[d] 169,000	+ 68,747
Total	118,413,637	129,293,206	150,143,177	117,179,527	137,966,791	+ 20,787,264
Total value	$113,390,507	$130,290,651	$155,664,026	$118,816,303	$130,085,237	+$11,268,934

[a] Includes production of Cameron County.
[b] Includes production of Bradford, Cameron, and McKean counties.
[c] Includes production of Bradford County.
[d] Includes production of Bradford and Cameron counties.

The statistics of the early production of bituminous coal in Pennsylvania, particularly as compared with the anthracite records, are sadly wanting. The United States census of 1840 showed a production of bituminous coal in the State, which amounted to 464,826 short tons. The census of 1860 showed a production of 2,690,786 short tons; that of 1870 showed a production of 7,798,518 short tons. The production for the intervening years, as shown in the table following, has been estimated from the best information obtainable. Since 1871 the records are official.

Production of bituminous coal in Pennsylvania from 1840 to 1909, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1840	464,826	1858	2,200,000	1876	12,880,000	1894	39,912,463
1841	475,000	1859	2,400,000	1877	14,000,000	1895	50,217,228
1842	500,000	1860	2,690,786	1878	15,120,000	1896	49,557,453
1843	650,000	1861	3,200,000	1879	16,240,000	1897	54,417,974
1844	675,000	1862	4,000,000	1880	18,425,163	1898	65,165,133
1845	700,000	1863	5,000,000	1881	22,400,000	1899	74,150,175
1846	760,000	1864	5,839,000	1882	24,640,000	1900	79,842,326
1847	399,840	1865	6,350,000	1883	26,880,000	1901	82,305,946
1848	500,000	1866	6,800,000	1884	28,000,000	1902	98,574,367
1849	750,000	1867	7,300,000	1885	26,000,000	1903	103,117,178
1850	1,000,000	1868	7,500,000	1886	27,094,501	1904	97,938,287
1851	1,200,000	1869	6,750,000	1887	31,516,856	1905	118,413,637
1852	1,400,000	1870	7,798,518	1888	33,796,727	1906	129,293,206
1853	1,500,000	1871	9,040,565	1889	36,174,089	1907	150,143,177
1854	1,650,000	1872	11,695,040	1890	42,302,173	1908	117,179,527
1855	1,780,000	1873	13,098,829	1891	42,788,490	1909	137,966,791
1856	1,850,000	1874	12,320,000	1892	46,694,576		
1857	2,000,000	1875	11,760,000	1893	44,070,724	Total	2,101,215,571

PHILIPPINE ISLANDS.[a]

OCCURRENCE.

Coal in the Philippines occurs with Tertiary shales and sandstones on nearly every island of the archipelago, with the greatest development in the Visayas. The coal is classed as subbituminous. The highest percentage of fixed carbon yet recorded is in a sample from the old Compostela mine in Cebu, 54 per cent. The coal is invariably low in ash. It has been found satisfactory for ordinary steaming purposes when burned on proper grates and with care in firing. The beds range from a few centimeters to 4 meters in thickness. They are usually, with the exception of those on the eastern part of Batan, inclined at all angles up to the vertical and are more or less faulted. The roof as a rule is firm and the cleats are good. The most favorable mining conditions so far found are on the eastern end of this island.

The principal coal localities in the archipelago are as follows:

Principal coal localities in Philippine Islands.

Location.	Province.	Island.
Batan Island	Albay	
Sugod Bay	do	Luzon.
Near Compostela	Cebu	Cebu.
Near Danao		
Polillo Island	Tayabas	
Cataingan	Sorsogon	Masbate.
Dimas Alang		
Bulalacao	Mindoro	Mindoro.
Silay River, Sibuguey Bay	Moro	Mindanao.

[a] Philippine Coal, by Warren D. Smith, and Coal in the Cagayan Valley, by H. G. Ferguson and R. N. Clark: The Mineral Resources of the Philippine Islands, with a statement of the production of commercial mineral products during the year 1909, Warren D. Smith, Chief of the Division of Geology and Mines, Bureau of Science, Manila, 1910, pp. 36-40, 41-42.

PROSPECTS.

Coal has long been known to exist in Luzon in the Cagayan Valley in the vicinity of Alcala, and in September, 1908, several of the outcrops were visited.[a] The first outcrop is about 3 kilometers north of Boggao, a small town about 10 kilometers up Pared River, a stream joining the Cagayan at Alcala. The coal, about a meter in thickness, outcrops in a small brook called the Wawing. A second outcrop, about 2 kilometers west of the first, occurs in the bed of a small stream flowing north; thickness unknown. Better coal is said to be found farther up Pared River in the San Jose Valley, near the barrio of Taytay.

To the northeast of Nasiping stretches a range of low, grass-covered hills among which the coal beds are located. The first bed visited lies north 35° east of Nasiping and 2.5 kilometers distant; the elevation by aneroid being 95 meters above the Cagayan River.

About 2 kilometers to the northeast of the steel bridge across the Tupong Creek and about 4 kilometers north of Alcala an outcrop was found in the bed of Tarya Creek, barrio of Maasin, and 45 meters above the Cagayan River. The coal at this place strikes north-northeast and dips 30° to the west-northwest. Directly above is a layer of black clay and below a lighter colored variety. The coal bed is but 0.5 meter in thickness.

This coal will probably never become available for the Manila market because of poor quality of coal and of thinness of beds; but mixed with Australian coal it might be useful for steamers on the Cagayan and also for steamers calling at Aparri.

Development work will soon be renewed on the old Spanish properties near Bacon on Sugod Bay, Luzon. Vigorous exploration was recently begun in the eastern portion of Masbate Island near Cataingan and Dimas Alang.

It is understood that operations will soon be resumed on the old properties near Compostela and Danao, on the east coast of Cebu, which properties remain in about the same condition in which they were at the beginning of 1909. The three fields under development are rather limited. A conservative estimate of the possible tonnage would be 2,000,000 workable tons in the Cumayjumayan Valley and 2,000,000 to 4,000,000 tons in the combined Mount Licos and Camansi fields. The coal beds are inclined at angles from 30° to 90°, and considerable minor faulting is evident. Five coal beds are known, at least three of which should be profitable, two being over 3 meters thick in one part of the field. About 100 tons of coal taken from the old galleries at the Licos workings have been on the dump for three or four years, and in that time the coal has not taken fire, nor has it "air-slaked" very greatly. The coal throughout the district is remarkably free from dirt, "butter," and "bone," and is quite low in sulphur. Labor conditions on the whole are good in Cebu, and in the Compostela-Danao district the natives have more or less familiarity with the underground work gained under the Spanish training. The present wage in this field is 40 centavos (20 cents) and subsistence for outside laborers, and 50 centavos for underground men. The Philippine Railroad Construction Company has found the native labor very

[a] Ferguson, H. G., and Clark, R. N., Coal in Cagayan Valley; op. cit., pp. 41–42.

satisfactory. The new railroad from the city of Cebu to Danao, about 20 miles, is completed. There is an old Spanish tramroad from Danao to the Comansi workings, about 5 miles long, with a rise of 250 feet. The transportation problem in other parts of the district is not so simple, and overhead cables or inclined planes will probably be found necessary. Dr. A. J. Cox, of the Chemical Laboratory, Bureau of Science, has discussed the composition of the coal in various papers.[a]

The geology of the island of Cebu was summarized by Warren D. Smith in 1907.[b]

DEVELOPMENT AND PRODUCTION.

Coal was first discovered in the Philippines in 1827 on the island of Cebu, the nearest approach to a successful coal mine during the Spanish régime being in that island.

The first concessions in the Compostela-Danao region were solicited by Isaac Conui in 1871. A wagon road was built from Cot-cot cove to the workings at Dapdap in 1877. The formation of the association known as the Sociedad Nuevo Langrea and the beginning of actual work took place about 1890. The construction of a tramroad from Danao to Camansi and from Compostela to Mount Licos was undertaken in 1895. The Spanish-American War in 1898 occurred. In this year all the concessions in this district came into the hands of Mr. Enrique Spitz. These have changed hands again and are controlled by the Insular Coal Company, which is now in the field carrying on exploratory work.

In 1907 and 1908 two companies were engaged in vigorous exploration of this field, the Insular Coal Company in the Mount Licos and Camansi region and a New York syndicate in the Cumayjumayan Valley, but there has been no further work. It is understood that negotiations are under way for the formation of a large company to mine this coal in the near future.[c] In 1904 the United States Army began developing work on the western end of Batan Island, and in 1905 work was begun on the East Batan Coal Company property. After more than a decade of prospecting and preparation under the new régime, including a number of false starts, the coal industry has passed beyond the stage of prospect. Two coal mines are now in operation in the Philippine Islands, both situated on the small island of Batan, Province of Albay, Luzon, and the only present coal production is from these mines. The United States Army coal mine produced and supplied to various vessels of the Army and the Navy 6,000 tons of coal during 1909.

This mine is located on the west end of the island of Liguan. Approximately 2½ kilometers of galleries, including entries, headings, cross holings, rooms, etc., have been opened up; these are confined to three principal beds, of which the uppermost at present furnishes the coal. This seam, outcropping at an elevation of 60 meters above sea level, is 1 meter thick; it is dipping at an angle of 45° to the northwest.

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[a] Phil. Jour. Sci., Sec. A (1906), 877; (1907), 2, 41; (1908), 3, 91, 301; (1909), 4, 171.
[b] Phil. Jour. Sci., Sec. A (1907), 2, 377.
[c] Burrit, Charles H., The Coal Measures of the Philippines: Report to the United States Military Governor in the Philippines, Washington, 1901.

The two lower ones are 40 feet apart and are, respectively, 1.54 meters and 1.33 meters in thickness. The measures at No. 4 entry on the upper seam, which is at present being used, are marked by a coarse grit or conglomerate full of quartz pebbles, both above and below the coal. This occurrence has not been noted in the coal measures on the eastern end of the island. This coal is quite firm and is superior in appearance to the Japanese coal sold in Manila. Recent tests show it to be better for steaming.

As was predicted in 1905, a number of small faults and rolls have been encountered. From my recent examination of the mine I do not think that these are so serious as to make the operations unprofitable; but it is clear that the mining of coal on this end of the island will call for the most experienced engineering ability.

Since our last report 198 meters of new dockage and a 2,000-ton bin with double tracks connecting it with the dock have been built.

The output with hand labor varies from 60 to 80 tons a day. This, however, is not regular. A number of changes and improvements have been made at the mine of the East Batan Coal Company.

The most important is the abandoning of the old and wasteful Japanese methods. With the arrival of Mr. Davy, a man experienced in underground work, the mine is being rapidly put into an up-to-date condition. The old method of working to the dip and robbing the ribs has been abandoned. It has been found that after the first 30 centimeters of the roof scales off, the rest stands with only a row of props, so that henceforth an immense amount of timbering can be avoided. This roof has a tendency to arch itself and it is quite likely that even props in the haulage ways can be dispensed with.

Since our last report 883 meters of new track have been laid, connecting the mine with a new dock, on which a very ingenious loading tower which travels on a track the whole length of the wharf has been erected. The tram cars have side doors, by means of which the coal is emptied into the loading bucket which is hoisted up to the required chute. There are four of the latter from which the coal slides into the ships' bunkers. The superintendent plans to change this system so that the tram car itself will be hoisted, thus obviating one handling of the coal. This loading tower is 14.5 meters high. The bucket holds 1 ton. The tram cars have a capacity of 2 tons. Other improvements are the digging of a new sump in the mine and the installation of an Emerson pump with a capacity of 757 liters a minute. A new 70-horsepower boiler is also being installed.

There are in all 6,096 meters of galleries, the main entry 295 meters at an angle of 15°, but 40° off the dip.

Although the production is not regular the average output is now 150 tons a day; when the present changes have been completed this will be increased to 200 or 250. It should be remembered that as yet no machines have been used. Mr. Daniels, manager, contemplates the installation of compressed-air drills, mule haulage, electric lights, and a number of other improvements within the year.

The coal pockets which the civil government proposes to erect here have not yet been constructed. They will be a very desirable addition to the plant.

The conditions for economical mining on this end of the island are very favorable. The coal seam now being worked is 1.7 meters thick and is perfectly uniform, seemingly without a trace of faulting and only a slight tendency to roll. It has fine face and butt cleats, so that there is no need of powder, nor has any accumulation of gas been noticed. If more efficient labor could be had the conditions would be ideal for long-wall mining. The method employed now is the "room and pillar."

This company as it is now organized, with Mr. Daniels as general manager and Mr. Davy in charge of the underground work, has every reason to expect a successful future. One shipment of coal from this property has recently been sold in Hongkong and another in Singapore. Tests on the briquetting of this coal will shortly be made by the United States Bureau of Mines at its Pittsburg office. The production of Philippine coal (almost wholly from Albay) during the last three years as reported to the Survey has been as follows:

Production of coal in Philippine Islands, 1907–1909, in short tons.

	Quantity.	Value.
1907	4,544	₱26,799 ($13,399)
1908	11,059	77,166 ($38,583)
1909	33,439	197,184 ($98,592)

Coke.[a]—During 1909 some development work was done in one locality in the Minanga Valley in Cebu. A sample of coal taken by Warren D. Smith was found to form a not very firm coke.

TENNESSEE.

Total production in 1909, 6,358,645 short tons; spot value, $6,920,564.

The progress of the coal-mining industry of Tennessee in 1909 was without noteworthy incident. There were no labor troubles of consequence or other interference with business. Production increased only slightly over 1908, but comparatively small as the increase was, the tonnage was apparently fully up to, if not in excess of, the market requirements, as was shown by a decline in the average price per ton from $1.15 to $1.09 and a decrease in the total value of the product. The production increased from 6,199,171 short tons in 1908 to 6,358,645 short tons in 1909, a gain of 159,474 tons, or 2.57 per cent. The value decreased from $7,118,499 to $6,920,564, a loss of $197,935, or 2.78 per cent. The prices obtained in 1909 were the lowest in many years, the averages in the last six years being $1.18 in 1904, $1.14 in 1905, $1.22 in 1906, $1.25 in 1907, $1.15 in 1908, and $1.09 in 1909.

There were fewer men employed in the coal mines of Tennessee in 1909 than in 1908, and the average production per man was correspondingly increased. In 1908 there were 11,812 men employed and in 1909, 10,031, a decrease of 1,781. The average production for each man employed increased from 525 in 1908 to 634 short tons in 1909. A part of this increased efficiency was due to the more general use of mining machinery and also, probably, to an increase in the number of days worked. Unfortunately, however, the statistics of labor employed in 1909 were not obtained in a manner to make the results in this report comparable with previous years. The number of mining machines in use increased from 122 in 1908 to 197 in 1909, and the

[a] The Mineral Resources of the Philippine Islands, 1910, p. 39.

quantity of machine-mined coal from 787,502 short tons to 1,040,798 short tons. The percentage of machine-mined coal to the total was 16.4 in 1909 against 12.7 in 1908. There were six companies that employed washing machinery in the preparation of the coal, principally for coke making, in 1909. The quantity of coal washed was 302,632 short tons, which yielded 271,565 tons of cleaned coal and 31,067 tons of refuse; in 1908, 278,928 tons of coal washed produced 258,477 tons of cleaned coal and 20,451 tons of refuse.

As already stated, production in Tennessee was not affected by labor difficulties. Strikes or suspensions occurred at only four mines. At two of these mines the difficulties were amicably settled, one after an idleness of 7 days and the other after 23 days. In one of the other two cases 90 union men went on strike on February 1 and were idle 65 days. The mine was kept running with nonunion labor. In the fourth instance 67 men were on strike, and although the strike was on for several months, the mine was idle only 15 days. In this case also the strikers were union and the mine was put on a nonunion basis.

Mr. J. W. Allen, statistician for the state bureau of mines, reports that in 1909 there were 31 men killed and 197 injured in the coal mines of Tennessee. The State was free from any serious explosion of gas and dust in 1909, no deaths and only one injury resulting from that cause. Eighteen men were killed and 98 injured by falls of roof and coal. Powder explosions and windy shots killed 3 and injured 10, and trip cars and motors killed 5 and injured 61. Two men were killed by electric currents. The number of widows and of fatherless children was not reported.

From 1891 to the close of 1909 the total number of accidental deaths in the coal mines of Tennessee was 682, and the number of nonfatal accidents in the same period, with four years missing, was 1,469. The causes of the accidents in the coal mines of the State have been reported irregularly, the total number of deaths for the causes specified being 373. Of those 373, falls of roof and coal caused 200, explosions of gas or dust caused 31, powder explosions and windy shots 35, and miscellaneous causes 107.

The statistics of production, by counties in 1908 and 1909, with the distribution of the product for consumption, are shown in the following table:

Coal production of Tennessee in 1908 and 1909, by counties, in short tons.

1908.

County	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Anderson	838,523	6,606	9,068	....	854,197	$951,535	$1.11	226	1,473
Campbell	1,542,521	17,411	19,983	4,628	1,584,543	1,938,100	1.22	193	3,102
Claiborne	1,130,826	7,050	20,290	....	1,158,166	1,161,348	1.00	211	1,511
Grundy	553,806	2,537	2,095	13,663	572,101	638,815	1.12	263	930
Hamilton	47,509	5,650	4,184	1,400	58,743	73,761	1.26	41	564
Marion	346,330	5,745	4,423	35,668	392,166	535,402	1.37	246	821
Morgan	466,751	4,653	11,152	102,578	585,134	651,214	1.11	239	1,203
Overton	44,809	499	770	....	46,078	52,199	1.13	148	177
Scott	114,745	12,761	931	....	128,437	175,796	1.37	129	559
Other counties[a]	482,851	29,722	29,819	276,705	819,097	939,118	1.15	245	1,472
Small mines	....	509	....	....	509	1,211	2.38	....	....
Total	5,568,671	93,143	102,715	434,642	6,199,171	7,118,499	1.15	209	11,812

[a] Bledsoe, Cumberland, Fentress, Franklin, Rhea, Roane, and White.

Coal production of Tennessee in 1908 and 1909, by counties, in short tons—Continued.

1909.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Anderson	802,285	8,212	12,306	....	822,803	$892,232	$1.08	....	....
Campbell	1,565,540	25,415	28,854	11,530	1,631,339	1,817,840	1.11	....	....
Claiborne	1,290,329	14,469	15,492	....	1,320,290	1,305,549	.99	....	....
Grundy	401,519	1,454	1,818	18,107	422,898	465,347	1.10	....	....
Marion	436,561	5,629	7,516	30,361	480,067	598,851	1.25	....	....
Morgan	346,215	11,073	11,556	100,693	469,537	408,931	.87	....	....
Overton	49,750	297	817	....	50,864	50,861	1.00	....	....
Scott	110,002	15,658	1,716	....	127,376	170,049	1.34	....	....
Other counties[a]	631,908	9,614	47,268	335,611	1,024,401	1,196,205	1.17	....	....
Small mines	....	9,070	....	....	9,070	14,699	1.62	....	....
Total	5,634,109	100,891	127,343	496,302	6,358,645	6,920,564	1.09	....	10,031

[a] Bledsoe, Cumberland, Fentress, Hamilton, Rhea, Roane, Sequatchie, and White.

The statistics of production, by counties, during the last five years, with increase and decrease in 1909 as compared with 1908, are shown in the following table:

Coal production of Tennessee, 1905–1909, by counties, in short tons.

County.	1905.	1906.	1907.	1908.	1909.	Increase (+) or decrease (−), 1909.
Anderson	845,778	763,834	851,943	854,197	822,803	− 31,394
Campbell	1,080,540	1,282,107	1,400,000	1,584,543	1,631,339	+ 46,796
Claiborne	1,020,453	1,099,747	1,147,900	1,158,166	1,320,290	+ 162,124
Cumberland	35,052	64,247	86,362	22,617	67,606	+ 44,989
Grundy	421,210	449,367	564,591	572,101	422,898	− 149,203
Hamilton	296,445	316,532	382,044	58,743	217,080	+ 158,337
Marion	416,768	389,525	401,416	392,166	480,067	+ 87,901
Morgan	620,587	615,705	639,207	585,134	469,537	− 115,597
Overton	84,493	81,603	74,734	46,078	50,864	+ 4,786
Rhea	240,590	264,918	242,421	173,719	104,128	− 69,591
Roane	122,403	158,421	170,748	162,669	188,016	+ 25,347
Scott	140,230	168,203	197,165	128,437	127,376	− 1,061
White	309,233	438,602	425,328	326,729	316,510	− 10,219
Other counties and small mines	132,908	166,464	226,384	133,872	140,131	+ 6,259
Total	5,766,690	6,259,275	6,810,243	6,199,171	6,358,645	+ 159,474
Total value	$6,577,881	$7,667,415	$8,490,334	$7,118,499	$6,920,564	−$197,935

The annual production of Tennessee from 1840 to the close of 1909 is shown in the following table:

Production of coal in Tennessee from 1840 to 1909, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1840	558	1858	135,000	1876	550,000	1894	2,180,879
1841	600	1859	150,000	1877	450,000	1895	2,535,644
1842	1,000	1860	165,300	1878	375,000	1896	2,663,106
1843	4,500	1861	150,000	1879	450,000	1897	2,888,849
1844	10,000	1862	140,000	1880	495,131	1898	3,022,896
1845	18,000	1863	100,000	1881	840,000	1899	3,330,659
1846	25,000	1864	100,000	1882	850,000	1900	3,509,562
1847	30,000	1865	100,000	1883	1,000,000	1901	3,633,290
1848	40,000	1866	100,000	1884	1,200,000	1902	4,382,968
1849	52,000	1867	110,000	1885	1,440,957	1903	4,798,004
1850	60,000	1868	125,000	1886	1,714,290	1904	4,782,211
1851	70,000	1869	130,000	1887	1,900,000	1905	5,766,690
1852	75,000	1870	133,418	1888	1,967,297	1906	6,259,275
1853	85,000	1871	180,000	1889	1,925,689	1907	6,810,243
1854	90,000	1872	224,000	1890	2,169,585	1908	6,199,171
1855	100,000	1873	350,000	1891	2,413,678	1909	6,358,645
1856	115,000	1874	350,000	1892	2,092,064		
1857	125,000	1875	360,000	1893	1,902,258	Total	96,862,417

The first reported production of coal in Texas is contained in the volume, Mineral Resources of the United States, 1884. The production reported to the United States Geological Survey for that year was 125,000 tons. The growth of the industry from that date to the close of 1909 is shown in the following table:

Coal production of Texas from 1884 to 1909, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1884	125,000	1891	172,100	1898	686,734	1905	1,200,684
1885	100,000	1892	245,690	1899	883,832	1906	1,312,873
1886	100,000	1893	302,206	1900	968,373	1907	1,648,069
1887	75,000	1894	420,848	1901	1,107,953	1908	1,895,377
1888	90,000	1895	484,959	1902	901,912	1909	1,824,440
1889	128,216	1896	544,015	1903	926,759		
1890	184,440	1897	639,341	1904	1,195,944	Total	18,164,765

UTAH.

Total production in 1909, 2,266,899 short tons; spot value, $3,751,810.

Utah's coal production in 1909 exceeded, for the first time in the history of the State, a total of 2,000,000 short tons. The output increased from 1,846,792 short tons, valued at $3,119,338, in 1908 to 2,266,899 short tons, valued at $3,751,810, in 1909, a gain of 420,107 short tons, or 22.4 per cent in quantity, and of $632,472, or 20.3 per cent, in value. Compared with 1907, when the previous highest tonnage was recorded, the production in 1909 showed an increase of 319,292 short tons in quantity and of $792,041 in value. The increase in 1909 was almost entirely from Carbon County, by far the most important producing county in the State. Carbon County alone produced more coal in 1909 than the entire State produced in any year prior to 1909, and Carbon County's increase in 1909 over 1908 was three times the total production of all the other counties combined. As in the other States of the Rocky Mountain region, Utah's increased coal production in 1909 was due to the revival in the metal-mining industry and to the general prosperity which came from good harvests in the agricultural sections. There was no interruption to mining operations due to labor troubles, and transportation facilities were better than usual in a "bumper" year.

The only mining machines in Utah mines are used in entry work, and no separation is made of the small tonnage resulting from such use.

Mr. J. E. Pettit, state mine inspector, reports that in 1909 there were 16 fatal accidents in the coal mines of Utah and 89 nonfatal accidents. None of these was due to explosions of gas or dust. Falls of roof or coal killed 11 and injured 51; 1 man was killed and 1 injured by powder explosions; and the other casualties were due to miscellaneous causes. Since 1893 (excluding 1894 and 1895, in which years the statistics of accidents were not compiled) there have been altogether 1,101 accidents, considering each death or injury a separate accident, in the coal mines of the State. Of this total, 307 were fatal and 794 nonfatal. Nearly 70 per cent of all the fatal accidents occurred in 1900, when an explosion at the Winter Quarters mines cost the lives of 200 men. With that notable exception the Utah mines have been practically free from accidents of this kind, the total number of deaths from this cause for the entire period, exclusive of 1900, being 17.

The statistics of production, by counties, in 1908 and 1909, with the distribution of the product for consumption, are shown in the following table:

Coal production of Utah in 1908 and 1909, by counties, in short tons.

1908.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Carbon	1,427,018	10,414	53,262	229,141	1,719,835	$2,889,564	$1.68	227	2,442
Emery	940	2,769	16		3,725	4,922	1.32	99	15
Summit	99,207	3,666	8,511		111,384	192,312	1.73	243	185
Morgan, Sanpete, Uinta		9,650			9,650	27,783	2.88	170	22
Small mines		2,198			2,198	4,757	2.16		
Total	1,527,165	28,697	61,789	229,141	1,846,792	3,119,338	1.69	227	2,664

1909.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Carbon	1,688,691	13,656	89,843	333,599	2,125,789	$3,545,144	$1.67		
Emery	417	1,273			1,690	2,761	1.63		
Summit	112,826	6,756	10,776		130,358	182,014	1.40		
Sanpete, Uinta		6,480			6,480	16,174	2.50		
Small mines		2,582			2,582	5,717	2.21		
Total	1,801,934	30,747	100,619	333,599	2,266,899	3,751,810	1.66		3,014

The production, by counties, during the last five years, with increase and decrease in 1909 as compared with 1908, has been as follows:

Coal production of Utah, 1905–1909, by counties, in short tons.

County.	1905.	1906.	1907.	1908.	1909.	Increase (+) or decrease (−), 1909.
Carbon	1,258,346	1,693,081	1,836,439	1,719,835	2,125,789	+ 405,954
Emery	3,692	4,954	5,052	3,725	1,690	− 2,035
Morgan, Sanpete	6,136	6,269	3,736	4,500	2,000	− 2,500
Summit, Uinta	61,966	67,043	102,025	116,534	134,838	+ 18,304
Small mines	2,232	1,204	355	2,198	2,582	+ 384
Total	1,332,372	1,772,551	1,947,607	1,846,792	2,266,899	+ 420,107
Total value	$1,793,510	$2,408,381	$2,959,769	$3,119,338	$3,751,810	+ $632,472

The areas in Utah known to contain workable beds of coal are estimated by M. R. Campbell to aggregate 13,130 square miles, and there are 2,000 square miles of which little is known, but which may contain workable beds of coal. The original contents of these fields are estimated by Mr. Campbell to have been 196,458,000,000 short tons of coal. The first production of coal in Utah was reported in the census year 1870, when 5,800 short tons were mined. In 1880 the census reported a total of 14,748 tons, although this was undoubtedly an underestimate. In 1890 the production had increased to 318,159 tons, and it reached an amount exceeding 1,000,000 tons for the first time in 1900 and reached its maximum output of 2,266,899 tons in 1909. The annual production since 1870 is shown in the following table:

Annual production of coal in Utah, 1870–1909, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1870	5,800	1881	52,000	1892	361,013	1903	1,681,409
1871		1882	100,000	1893	413,205	1904	1,493,027
1872		1883	200,000	1894	431,550	1905	1,332,372
1873		1884	200,000	1895	471,836	1906	1,772,551
1874		1885	213,120	1896	418,627	1907	1,947,607
1875		1886	200,000	1897	521,560	1908	1,846,792
1876	50,400	1887	180,021	1898	593,709	1909	2,266,899
1877	50,400	1888	258,961	1899	786,049		
1878	67,200	1889	236,651	1900	1,147,027	Total	22,950,873
1879	50,000	1890	318,159	1901	1,322,614		
1880	14,748	1891	371,045	1902	1,574,521		

VIRGINIA.

Total production in 1909, 4,752,217 short tons; spot value, $4,251,056.

Virginia was one of the few States, and one of three east of Mississippi River, whose production of coal in 1909 exceeded that of 1907, which had held the record. The new record for Virginia's production in 1909 was due to increased production in Wise County and to active development in Russell County. Wise County, which contributes at the present time about 60 per cent of the State's total, increased its production from 2,558,874 short tons in 1908 to 2,841,448 tons in 1909. Russell County's production increased more than 100 per cent, but, as the entire output is made by one company, the figures are not divulged. Tazewell County produced 4,349 short tons less in 1909 than in 1908, and Lee County's production fell off 15,117 short tons. The net increase for the State was 493,175 short tons, or 11.5 per cent, from 4,259,042 short tons in 1908 to 4,752,217 short tons in 1909. The value increased $382,532, or 9.9 per cent, from $3,868,524 to $4,251,056. Compared with 1907, the output in 1909 exhibited a gain of 41,322 short tons in quantity, but the value of the product was more than $550,000 less in 1909 than in 1907. The average price per ton was 89 cents in 1909 against 91 cents in 1908 and $1.02 in 1907.

There was a significant increase shown in the number of mining machines in 1909 and in the quantity of coal mined by them. The number of machines in use increased from 85 in 1908 to 107 in 1909, and the machine-mined tonnage increased from 1,035,832 to 1,323,111 tons. In 1907 the quantity of coal mined by machines was 788,793 tons, and in 1906 it was 424,343 tons. In 1909 the production by the use of machines was more than three times that of 1906, and was nearly 30 per cent of the total quantity of coal mined in 1909. None of the coal produced in Virginia is washed before being sold or used.

There is no state officer charged with the duty of the inspection of mines nor of collecting the statistics relative to mine accidents. Inquiries made of the operators by the Geological Survey for 1909 show that in that year there were 27 men killed and 373 injured. There were no deaths nor injuries due to explosion of gas or dust. Sixteen deaths, or almost two-thirds of the total number, were due to falls of roof and coal, and 120 of the nonfatal accidents were from the same cause.

The statistics of production by counties in 1908 and 1909, with the distribution of the production for consumption, are shown in the following table:

Coal production of Virginia in 1908 and 1909, by counties, in short tons.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
1908.									
Lee	348,240	13,210	8,720	94,091	464,261	$429,531	$0.93	234	621
Tazewell	766,533	21,987	36,558	154,936	980,014	971,927	.99	150	1,677
Wise	989,831	27,154	54,753	1,487,136	2,558,874	2,204,093	.86	204	3,324
Other counties[a] and small mines	239,704	5,549	10,640	....	255,893	262,973	1.03	280	586
Total	2,344,308	67,900	110,671	1,736,163	4,259,042	3,868,524	.91	200	6,208
1909.									
Lee	330,582	3,120	6,304	109,138	449,144	$404,078	$0.90	....	....
Tazewell	689,164	8,698	40,366	237,437	975,665	917,229	.94	....	....
Wise	1,223,572	29,767	120,104	1,468,005	2,841,448	2,463,588	.87	....	....
Other counties[a] and small mines	458,796	12,123	15,041	....	485,960	466,161	.96	....	....
Total	2,702,114	53,708	181,815	1,814,580	4,752,217	4,251,056	.89	....	6,191

[a] Montgomery, Pulaski, and Russell.

The statistics of production, by counties, for the last five years, with increase and decrease in 1909 as compared with 1908, are shown in the following table:

Coal production of Virginia, 1905–1909, by counties, in short tons.

County.	1905.	1906.	1907.	1908.	1909.	Increase (+) or decrease (−), 1909.
Tazewell	961,380	910,638	1,116,534	980,014	975,665	− 4,349
Wise	2,990,698	3,041,225	3,145,846	2,558,874	2,841,448	+ 282,574
Pulaski	[a] 323,073	[a] 302,896	[a] 448,515	[a] 719,954	[a] 931,276	+ 211,322
Small mines	120	120	....	200	3,828	+ 3,628
Total	4,275,271	4,254,879	4,710,895	4,259,042	4,752,217	+ 493,175
Total value	$3,777,325	$4,183,991	$4,807,533	$3,868,524	$4,251,056	+ $382,532

[a] Includes Lee, Montgomery, and Russell counties.

The first bituminous coal mined in the United States was taken from what is usually termed the Richmond Basin, a small area of Triassic age in the southeastern portion of the State, near the city of Richmond. This basin is situated on the eastern margin of the Piedmont Plateau, 13 miles above tide, on James River. It lies in Goochland, Henrico, Powhatan, and Chesterfield counties.

Coal was known to be present in the Richmond Basin as early as 1700, and it was used in the latter quarter of the eighteenth century.

In 1789 shipments were made to some of the northern States. In 1822, according to Mr. R. C. Taylor, the production amounted to 48,214 long tons or 54,000 short tons. Owing to the competition of New River and Pocahontas coals mining operations were practically suspended in the Richmond Basin during the latter part of the nineteenth and the first few years of the present century. In 1908, however, the redevelopment of the mines at Gayton and the rehabilitation of the mining industry in the district was undertaken by the Old Dominion Development Company, a New York corporation. According to press reports the properties have been equipped with modern machinery, the water that had accumulated in the years of idleness pumped out, and mines put in condition for a considerable tonnage. The mines are located on the line of the Richmond, Fredericksburg and Potomac Railroad, and it is proposed to use the coal on the freight locomotives of that road, and to supply the local trade of Richmond and vicinity.

With the completion of the Norfolk and Western Railway in 1882 the coal fields in the southwestern part of the State, which belong to the Appalachian system, were opened. A portion of the famous Pocahontas district is included within the county of Tazewell, in Virginia, and the construction of the Clinch Valley Branch of the Norfolk and Western Railway in 1892 opened valuable coal lands in Wise County, which has since become the most important producing district in the State.

The development of the Black Mountain field, in Lee County, following the completion of railroad connections from Pennington Gap to Appalachia, was begun in 1905, and a small production was reported in 1906. In 1907 the output of this county amounted to nearly 200,000 tons; in 1908, to more than 460,000 tons; but in 1909 it fell back to a little less than 450,000 tons. Further development of this district is anticipated, and it is expected to increase the production of the State materially.

The annual production of Virginia from 1822 to the close of 1909 is shown in the following table:

Production of coal in Virginia from 1822 to 1909, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1822	54,000	1845	350,000	1868	59,051	1891	736,399
1823	60,000	1846	340,000	1869	65,000	1892	675,205
1824	67,040	1847	325,000	1870	61,803	1893	820,339
1825	75,000	1848	318,000	1871	70,000	1894	1,229,083
1826	88,720	1849	315,000	1872	69,440	1895	1,368,324
1827	94,000	1850	310,000	1873	67,200	1896	1,254,723
1828	100,080	1851	310,000	1874	70,000	1897	1,528,302
1829	100,000	1852	325,000	1875	60,000	1898	1,815,274
1830	102,800	1853	350,000	1876	55,000	1899	2,105,791
1831	118,000	1854	370,000	1877	50,000	1900	2,393,754
1832	132,000	1855	380,782	1878	50,000	1901	2,725,873
1833	125,000	1856	352,687	1879	45,000	1902	3,182,993
1834	124,000	1857	363,605	1880	43,079	1903	3,451,307
1835	120,000	1858	377,690	1881	50,000	1904	3,410,914
1836	124,000	1859	359,055	1882	112,000	1905	4,275,271
1837	160,000	1860	473,360	1883	252,000	1906	4,254,879
1838	300,000	1861	445,165	1884	336,000	1907	4,710,895
1839	396,000	1862	445,124	1885	567,000	1908	4,259,042
1840	424,894	1863	[a] 40,000	1886	684,951	1909	4,752,217
1841	379,600	1864	40,000	1887	825,263		
1842	373,640	1865	40,000	1888	1,073,000	Total	66,240,411
1843	370,000	1866	40,000	1889	865,786		
1844	365,000	1867	50,000	1890	784,011		

[a] West Virginia separated from Virginia.

WASHINGTON.

Total production in 1909, 3,602,263 short tons; spot value, $9,158,999.

Washington is the only State west of the Rocky Mountains that rises to any importance as a coal producer. In 1909 the coal production of Washington amounted to 3,602,263 short tons, an increase of 577,320 short tons, or 19 per cent, over 1908, and approaching within 78,269 tons the maximum record of 1907. When the value of the product is taken as a basis of comparison it appears that the value of the output in 1909 showed a phenomenal gain of 37 per cent over 1908, from $6,690,412 to $9,158,999 (an increase of $2,468,587), and exceeded by more than $1,400,000 the value of the slightly larger tonnage produced in 1907. The greater part of this apparently disproportionate increase in value was reported from Kittitas County, the most important coal-producing county in the State. More than 85 per cent of the production in this county is from the mines affiliated with and controlled by the Northern Pacific Railway, and all of the production is taken by the railway, none going on the open market. The unusual increase in value in 1909, therefore, can not be attributed to any marked improvement in trade conditions. It is to be noted, however, that in King County, next to Kittitas County in producing importance, and contributing 30 per cent of the State's total, the average price advanced from $2.21 to $2.34, and most of the production of this county was commercial coal. In Pierce County, the third in rank, there was a slight decline in price from an average of $2.49 in 1908 to $2.46 in 1909.

Until 1908 the use of machines for undercutting coal had shown little progress in the mines of Washington, attempts to produce coal mechanically previous to that date having met with indifferent success. In 1908, however, 4 pick machines were reported as having been used in the production of 20,000 short tons of coal; in 1909 there were 18 machines in use, 15 pick and 3 chain, and the machine-mined coal amounted to 48,690 short tons.

Twelve of the pick machines used in the coal mines of Washington during 1909 were of the post-puncher type recently brought out, which are adapted to the mechanical mining of coal in steeply dipping beds. The mine in which these 12 machines worked in 1909 has a dip of 39°. In the old type of puncher machines it is not possible to operate in a bed dipping more than 15°, and with the chain machines an inclination of 12° is the limit at which this type can be employed.

Notwithstanding the increased production in 1909, the quantity of coal washed was 50,000 tons less than in 1908, the quantity washed in 1909 being 1,048,177 short tons, that yielded 778,038 tons of cleaned coal and 270,139 tons of refuse, against 1,098,879 short tons of coal washed in 1908, that yielded 859,942 tons of cleaned coal and 238,937 tons of refuse.

In a period of fifteen years the total number of deaths in the coal mines of Washington was 532, with 1,223 injured. Of the fatal accidents about 30 per cent were due to explosions, most of which were explosions of gas. Some of the mines in Washington are highly gaseous, and the percentage of deaths from gas explosions is higher than in most of the other States producing bituminous coal and is considerably above the average for the country taken for a period of years. On the other hand, the percentage of deaths from falls of roof or coal is smaller in Washington than in other States—23.31 per cent as compared with an average of 43.95 in the United States. Mr. D. C. Botting, state mine inspector, reports that there were 39 fatal and 136 nonfatal accidents in 1909, as compared with 25 fatal and 79 nonfatal in 1908. Of the fatal accidents, 14 were due to gas explosions. As reported, the production of coal in 1909 amounted to 3,602,263 short tons; the quantity of coal mined for each life lost was 92,366 tons, and the death rate per thousand of employees was 6.51, as compared with 120,998 tons mined for each fatality and a death rate of 4.56 in 1908.

The statistics of production, by counties, in 1908 and 1909, with the distribution of the product for consumption, are shown in the following table:

Coal production of Washington in 1908 and 1909, by counties, in short tons.

1908.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
King	800,182	69,184	59,277	3,000	931,643	$2,058,908	$2.21	192	1,691
Kittitas	1,357,073	20,328	37,220	....	1,414,621	2,993,113	2.12	188	2,230
Lewis	60,438	7,065	6,172	....	73,675	164,090	2.23	233	162
Pierce	448,174	8,882	28,952	65,670	551,678	1,373,298	2.49	239	1,249
Other counties [a]	50,053	785	2,488	....	53,326	101,003	1.89	182	152
Total	2,715,920	106,244	134,109	68,670	3,024,943	6,690,412	2.21	202	5,484

1909.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
King	1,107,449	32,828	75,735	....	1,216,012	$2,842,118	$2.34	....	....
Kittitas	1,492,053	16,077	42,409	....	1,550,539	4,370,633	2.82	....	....
Lewis	97,524	21,218	2,831	....	121,573	267,211	2.20	....	....
Pierce	502,613	4,197	32,949	69,708	609,467	1,501,587	2.46	....	....
Other counties [b]	102,598	330	1,694	....	104,622	177,312	1.69	....	....
Small mines	....	50	....	....	50	138	2.76	....	....
Total	3,302,237	74,700	155,618	69,708	3,602,263	9,158,999	2.54	....	5,992

[a] Clallam, Thurston, and Whatcom. [b] Thurston, Whatcom, and Yakima.

As will be seen from the following table giving the production by counties during the last five years, the record for 1909 shows an increase in each county over 1908. The largest increase was in King County, which showed a gain of 284,369 short tons, which was, however, more than 44 per cent less than the decrease shown from 1907 to 1908, so that the production in that county in 1909 fell considerably below that of 1907. In Kittitas County the production in 1909 increased 135,918 short tons, and was 25,652 tons more than the maximum output of two years before. Pierce County increased 57,789 tons in production, and Lewis County, 47,898 tons, and an increase of a little over 50,000 tons was shown in the output of the less important counties and of the small mines whose production is not distributed according to counties.

Production of coal in Washington, 1905–1909, by counties, in short tons.

County.	1905.	1906.	1907.	1908.	1909.	Increase (+) or decrease (−), 1909.
Cowlitz	[a] 3,706	[a] 3,523	[a] 7,424	([b])	([b])	....
King	1,099,163	1,310,530	1,445,633	931,643	1,216,012	+ 284,369
Kittitas	1,280,845	1,422,612	1,524,887	1,414,621	1,550,539	+ 135,918
Lewis	1,300	25,880	103,530	73,675	121,573	+ 47,898
Pierce	479,912	513,639	572,169	551,678	609,467	+ 57,789
Whatcom	....	....	....	([c])	([c])	....
Other counties	....	....	26,880	53,326	[d] 104,672	+ 51,346
Total	2,864,926	3,276,184	3,680,532	3,024,943	3,602,263	+ 577,320
Total value	$5,141,258	$5,908,434	$7,679,801	$6,690,412	$9,158,999	+$2,468,587

[a] Includes Whatcom County.
[b] No production in Cowlitz County.
[c] Included in other counties.
[d] Includes small mines.

The United States census report for 1860 contains the first record of coal production in Washington. This production was entirely from the Bellingham Bay properties, in Whatcom County, and amounted to 5,374 tons. The State did not assume much importance as a coal producer, however, until the opening of the Green River field, in King County, between 1880 and 1885, and of the Roslyn mines, in Kittitas County, which began producing about the same time. The growth of the industry since 1860, when production in Washington began, is shown in the following table:

Production of coal in Washington, 1860–1909, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1860	5,374	1873	26,000	1886	423,525	1899	2,029,881
1861	6,000	1874	30,352	1887	772,601	1900	2,474,093
1862	7,000	1875	99,568	1888	1,215,750	1901	2,578,217
1863	8,000	1876	110,342	1889	1,030,578	1902	2,681,214
1864	10,000	1877	120,896	1890	1,263,689	1903	3,193,273
1865	12,000	1878	131,660	1891	1,056,249	1904	3,137,681
1866	13,000	1879	142,666	1892	1,213,427	1905	2,864,926
1867	14,500	1880	145,015	1893	1,264,877	1906	3,276,184
1868	15,000	1881	196,000	1894	1,106,470	1907	3,680,532
1869	16,200	1882	177,340	1895	1,191,410	1908	3,024,943
1870	17,844	1883	244,990	1896	1,195,504	1909	3,602,263
1871	20,000	1884	166,936	1897	1,434,112		
1872	23,000	1885	380,250	1898	1,884,571	Total	49,735,903

WEST VIRGINIA.

Total production in 1909, 51,849,220 short tons; spot value, $44,661,716.

In 1909, for the second time in the history of the coal-mining industry, the production of West Virginia exceeded that of Illinois and the former took second place in the rank of coal-producing States. This occurred in a year in which mining operations were not disturbed by labor troubles of any consequence in either State. The previous occasion when West Virginia outranked Illinois was in 1906, when the production in Illinois was cut down by an extended period of idleness precipitated by the biennial struggle between the operators and the organized mine workers over the settlement of the wage scale. In that year, 1906, West Virginia's production exceeded that of Illinois by 1,810,246 short tons. The production of Illinois was again reduced in 1908, but on account of the marked depression of the iron trade the output of West Virginia fell off even more than did that of Illinois, and the latter held its place. Without these disturbing elements in 1909 West Virginia again took the lead with a production of 944,230 tons larger than that of Illinois.

On account of the unforeseen and unavoidable delays in the collection of the statistics and the preparation of the report for 1909, another year, 1910, has passed into history at the time this chapter is written. It will long be remembered by the coal trade as chronicling one of the most prolonged wage-scale strikes in the history of bituminous-coal mining. Illinois and the Southwestern States were the ones most seriously affected, the greater number of the important producing mines in Illinois being idle for five and a half months. In consequence of this West Virginia's production in that year (1910) will show a lead over Illinois of from 10,000,000 to 15,000,000 tons, and with the advantage thus gained will have probably established itself permanently as the second coal-producing State.

The production in West Virginia in 1909 amounted to 51,849,220 short tons, valued at $44,661,716, against 41,897,843 short tons, valued at $40,009,054 in 1908. The increase in 1909 was 9,951,377 short tons, or 23.7 per cent, in quantity, and $4,652,662, or 11.6 per cent, in value, the percentage of increase in production being more than double the percentage gain in value. The average price per ton declined from 95 cents in 1908 to 86 cents in 1909, in connection with which another comparison with the rival State, Illinois, is pertinent. The comparison is one not so much to the disadvantage of Illinois. The coals of Illinois can not be said to equal in quality those of West Virginia, and yet the average price for Illinois coals in 1909 was $1.05, while that of West Virginia coals was 86 cents. The price for Illinois coals has for several years ranged from 10 to 20 per cent higher than the price received for West Virginia coals, and if the difference in the quality of the products were considered the difference would be from 20 to 30 per cent. Illinois coals have the advantage of neighboring markets, and by far the larger part of the product is consumed within the State or in adjacent territory. West Virginia, on the other hand, more than any other coal-producing State, depends upon market conditions outside of the State borders for the disposition of its product. The manufacturing industries of West Virginia are comparatively unimportant when considered in connection with its large and cheap supply of high-grade fuel. Probably more than 50 per cent of West Virginia's coal production is shipped away to support manufacturing industries in other States, for, with the exception of what goes into railroad consumption and a comparatively small quantity used for manufacturing purposes (particularly along Ohio River), added to that used for purely domestic consumption, all of the State's production of coal—some of it the highest quality of bituminous coal produced in the United States—is shipped outside of the State for consumption. The moral is obvious.

According to the returns to the Bureau of the Census, there were 55,433 men employed in the coal mines of West Virginia in 1909, but the average number of days worked has not been reported in a manner comparable with the statistics compiled by the Geological Survey for previous years. The average production per man in 1909 was 935 tons, against an average of 737 tons per man in 1908. There was much complaint of labor shortage in 1909, and it is stated that the mines of West Virginia could have given employment to 18,000 more miners and mine laborers than were available during the year. Complaint was also made of shortage of cars at the mines on the Chesapeake and Ohio, the Norfolk and Western, and the Baltimore and Ohio railroads, and Mr. John Laing, chief of the State department of mines, is authority for the statement that the mines were idle an average of from one to two days a week from that cause. A part of the labor shortage was attributed to the exodus of miners to Europe during the business depression of 1908.

The increase in the proportion of coal mined by machines, mentioned in the report for 1908, continued in 1909. The number of machines increased from 1,574 in 1908 to 1,844 in 1909, and the quantity of machine-mined coal increased from 16,653,174 short tons in 1908 to 20,993,489 short tons in 1909. The percentage of the machine-mined product to the total increased from 39.75 to 40.8. Of the 1,844 machines in use in 1909, 700 were punchers, 1,030 chain breast, and 108 longwall. There were also 6 chain machines used for shearing. There were 58 mines in which a total of 414 punchers were exclusively used that produced 2,207,277 short tons of coal, an average of 5,332 tons to each machine. In 91 mines a total of 572 chain machines produced 8,542,906 short tons, an average of 14,900 tons to each machine. The average production for the total of 1,844 machines was 11,385 short tons.

During the period of twenty-three years for which the statistics are available, there have been in the coal mines of West Virginia a total of 3,311 deaths and 5,102 injuries. The deaths from gas and dust explosions were 930, of which more than one-half occurred in the explosion at Monongah on December 14, 1907. Nearly 50 per cent (1,472) of the deaths resulted from falls of roof and coal, and 2,475, also nearly 50 per cent, of the nonfatal accidents were due to this cause. In 1909, according to the report of Mr. Laing, there were 364 fatal and 1,032 nonfatal accidents in the coal mines of West Virginia. Of the fatal accidents, 119 were attributable to explosions of gas or dust. The most serious disaster during the year was an explosion at the Lick Branch colliery of the Pocahontas Consolidated Colliery Company, on December 29, when approximately 100 lives were lost. Falls of roof and coal killed 144 men and injured 504. These figures represent the fiscal year ended June 30, this being the year covered by the mine inspector's report. Mr. Laing reports the output for the fiscal year ended June 30, 1909, as 46,671,971 short tons, in the production of which 58,582 men were employed. The number of tons mined for each life lost was 128,220, and the death rate per thousand was 6.22, against 133,859 tons mined for each fatality and a death rate of 5.5 in 1908. Of the 364 men killed in 1909, 141 left widows and a total of 324 children.

The statistics of production, by counties, in 1908 and 1909, with the distribution of the product for consumption, are shown in the following table:

Coal production of West Virginia in 1908 and 1909, by counties, in short tons.

1908.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Barbour	921,860	12,340	20,735	68,094	1,023,029	$825,055	$0.81	194	1,238
Brooke	421,364	10,384	1,625	....	433,373	414,319	.96	175	660
Fayette	6,778,459	100,896	176,550	607,656	7,663,561	7,921,704	1.03	179	11,747
Harrison	3,204,378	25,670	30,549	2,040	3,262,637	2,674,521	.82	172	3,959
Kanawha	4,492,872	59,994	77,682	....	4,630,548	4,574,316	.99	157	7,543
Logan	1,652,912	15,022	15,522	....	1,683,456	1,586,388	.94	187	1,761
McDowell	5,982,099	85,881	184,877	2,348,945	8,601,802	8,567,449	.99	192	11,487
Marion	3,718,088	24,929	59,673	119,708	3,922,398	3,514,553	.90	214	3,892
Marshall	189,178	60,056	10,535	....	259,769	253,539	.98	132	462
Mason	68,828	34,089	16,806	....	119,723	122,104	1.02	167	284
Mercer	1,741,387	17,288	37,943	291,725	2,088,343	1,902,613	.91	203	2,300
Mineral	691,024	2,967	2,235	....	696,226	631,631	.91	190	818
Mingo	1,748,185	17,646	34,758	....	1,800,589	1,591,536	.88	216	2,213
Monongalia	113,686	2,357	9,577	99,335	224,955	217,867	.97	220	359
Ohio	121,951	22,911	1,125	....	145,987	152,699	1.05	171	201
Preston	423,820	11,053	22,322	202,153	659,348	564,701	.86	162	1,058
Putnam	502,199	17,128	13,119	....	532,446	652,330	1.23	251	971
Raleigh	1,562,140	24,042	35,979	....	1,622,161	1,618,357	.99	189	2,708
Randolph	249,718	2,756	5,394	103,983	361,851	302,977	.84	130	358
Taylor	472,515	10,413	2,741	3,400	489,069	355,514	.73	182	646
Tucker	772,793	22,519	21,694	163,419	980,425	909,294	.93	195	1,365
Other counties[a] and small mines	611,366	61,186	23,571	24	696,147	655,587	.94	201	831
Total	36,440,822	641,527	805,012	4,010,482	41,897,843	40,009,054	.95	185	56,861

1909.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Barbour	883,375	4,827	14,890	121,713	1,024,805	$791,342	$0.77	......	......
Braxton	103,086	1,999	629	....	105,714	90,547	.86	......	......
Brooke	373,210	4,588	3,089	....	380,887	366,413	.96	......	......
Clay	41,300	399	1,513	....	43,212	41,779	.96	......	......
Fayette	8,518,913	112,511	199,155	1,046,942	9,877,521	9,015,117	.91	......	......
Gilmer	37,176	2,925	100	....	40,201	28,673	.71	......	......
Grant	176,752	764	13,059	....	190,575	163,276	.86	......	......
Harrison	3,332,392	13,970	37,389	1,540	3,385,291	2,564,091	.76	......	......
Kanawha	5,418,298	69,771	76,953	12,116	5,577,138	4,748,369	.85	......	......
Lincoln	48,332	1,514	1,381	....	51,227	48,776	.95	......	......
Logan	2,097,059	21,760	29,146	....	2,147,965	1,778,356	.83	......	......
McDowell	8,285,144	130,449	225,912	3,323,331	11,964,836	10,215,373	.85	......	......
Marion	3,967,268	18,552	76,022	133,631	4,195,473	3,474,556	.83	......	......
Marshall	250,306	100,025	6,288	....	356,619	351,703	.99	......	......
Mason	81,457	22,882	12,870	....	117,209	127,122	1.08	......	......
Mercer	1,977,101	23,336	42,159	468,404	2,511,000	2,155,219	.86	......	......
Mineral	883,296	5,515	3,434	....	892,245	813,140	.91	......	......
Mingo	1,964,962	37,592	37,086	....	2,039,640	1,672,864	.82	......	......
Monongalia	145,110	5,527	12,448	208,805	371,890	287,583	.77	......	......
Nicholas	35,802	110	802	....	36,714	46,009	1.25	......	......
Ohio	159,653	75,205	2,012	....	236,870	232,106	.98	......	......
Preston	505,441	18,170	22,823	450,333	996,767	860,701	.86	......	......
Putnam	547,938	8,705	18,366	....	575,009	690,248	1.20	......	......
Raleigh	2,337,827	27,311	46,375	....	2,411,513	2,091,875	.87	......	......
Randolph	227,711	1,963	6,447	156,725	392,846	338,095	.86	......	......
Taylor	476,515	4,270	3,121	....	483,906	327,561	.68	......	......
Tucker	880,371	8,385	35,180	233,817	1,157,753	1,070,468	.92	......	......
Upshur	77,921	962	1,732	....	80,615	63,483	.79	......	......
Other counties[b] and small mines	112,587	88,690	2,502	....	203,779	206,871	1.02	......	......
Total	43,946,303	812,677	932,883	6,157,357	51,849,220	44,661,716	.86	......	55,433

[a] Boone, Braxton, Clay, Gilmer, Grant, Greenbrier, Hancock, Lewis, Lincoln, Nicholas, Ritchie, and Upshur.
[b] Boone, Greenbrier, Hancock, Lewis, Ritchie, and Wood.

The statistics of production, by counties, during the last five years, with increase and decrease in 1909 as compared with 1908, are shown in the following table:

Coal production of West Virginia, by counties, 1905–1909, in short tons.

County.	1905.	1906.	1907.	1908.	1909.	Increase (+) or decrease (−), 1909.
Barbour	615,437	993,681	1,175,763	1,023,029	1,024,805	+ 1,776
Braxton	....	....	....	....	105,714	+ 105,714
Brooke	239,396	483,256	454,119	433,373	380,887	− 52,486
Clay	80,424	79,385	63,747	6,622	43,212	+ 36,590
Fayette	7,985,327	8,260,307	8,599,978	7,663,561	9,877,521	+ 2,213,960
Gilmer	....	....	....	....	40,201	+ 40,201
Grant	207,926	297,026	312,407	217,074	190,575	− 26,499
Hancock	57,683	70,251	87,100	85,631	75,633	− 9,998
Harrison	2,850,678	3,626,337	3,939,965	3,262,637	3,385,291	+ 122,654
Kanawha	3,973,717	4,880,307	5,588,074	4,630,548	5,577,138	+ 946,590
Lincoln	....	....	....	....	51,227	+ 51,227
Logan	223,319	592,895	1,248,522	1,683,456	2,147,965	+ 464,509
McDowell	8,245,167	8,707,677	9,840,975	8,601,802	11,964,836	+ 3,363,034
Marion	3,621,219	4,163,462	4,228,231	3,922,398	4,195,473	+ 273,075
Marshall	438,773	511,335	612,605	259,769	356,619	+ 96,850
Mason	95,786	112,660	150,726	119,723	117,209	− 2,514
Mercer	2,269,076	2,199,830	2,344,426	2,088,343	2,511,000	+ 422,657
Mineral	575,294	661,938	746,668	696,226	892,245	+ 196,019
Mingo	1,679,526	2,210,276	2,229,436	1,800,589	2,039,640	+ 239,051
Monongalia	218,360	328,408	424,997	224,955	371,890	+ 146,935
Nicholas	58,179	79,635	82,246	41,629	36,714	− 4,915
Ohio	109,201	121,464	187,545	145,987	236,870	+ 90,883
Preston	837,666	1,129,344	1,286,535	659,348	996,767	+ 337,419
Putnam	548,767	548,725	437,073	532,446	575,009	+ 42,563
Raleigh	827,868	1,105,318	1,412,393	1,622,161	2,411,513	+ 789,352
Randolph	517,078	387,762	671,417	361,851	392,846	+ 30,995
Taylor	348,105	445,427	475,237	489,069	483,906	− 5,163
Tucker	1,095,059	1,199,041	1,217,267	980,425	1,157,753	+ 177,328
Upshur	....	....	....	....	80,615	+ 80,615
Other counties and small mines	72,549	94,603	274,131	345,191	128,146	− 217,045
Total	37,791,580	43,290,350	48,091,583	41,897,843	51,849,220	+ 9,951,377
Total value	$32,341,790	$41,051,939	$47,846,630	$40,009,054	$44,661,716	+$4,652,662

For commercial purposes the principal coal-producing regions of West Virginia may be divided into four distinct districts. These may be distinguished by certain geographic or physiographic features. They do not include all of the coal-producing counties of the State, but do include the more important ones, and they contributed over 90 per cent of the total output of the State in 1909. Two of these districts are in the northern portion of the State and two in the southern portion. The two in the northern portion are designated, respectively, the Fairmont or upper Monongahela district and the Elk Garden or upper Potomac; those in the southern portion of the State are the Pocahontas or Flat Top district and the New and Kanawha rivers district.

The upper Monongahela district is penetrated by the Baltimore and Ohio Railroad and sends its coal to market over that highway. The upper Potomac region also is reached by the Baltimore and Ohio Railroad and is penetrated by the West Virginia Central and Pittsburg Railway. The Pocahontas or Flat Top region is tributary to the main branch of the Norfolk and Western Railway; all of the product of this district goes either west or to tide water over that line. The New and Kanawha rivers district is named from the two rivers which drain it, the coal being shipped partly by the Chesapeake and Ohio Railway and the Kanawha and Michigan Railway, which pass through it, and partly by barges on Kanawha River. The Virginian Railway, to which reference has already been made, will afford additional transportation to both the Pocahontas or Flat Top and the New River districts. The most important district from the productive point of view is that of New and Kanawha rivers, which embraces the counties of Fayette, Kanawha, Raleigh, and Putnam. The coal from these four counties is drawn from two different areas, most of the coal from Kanawha and Putnam counties being from a higher geologic horizon than that of Fayette and Raleigh counties, but the district is practically compact and continuous and is drained by the same waters and reached by the same railroads, so the two areas are considered as one district in this report.

Coal production of the principal districts of West Virginia, 1886–1909, in short tons.

Year.	New and Kanawha rivers district.[a]	Pocahontas, or Flat Top district.[b]	Fairmont, or upper Monongahela, district.[c]	Upper Potomac, or Elk Garden, district.[d]
1886	2,290,563	968,484	406,976	383,712
1887	2,379,296	1,357,040	520,064	503,343
1888	2,840,630	1,912,695	473,489	518,878
1889	2,669,016	2,290,270	456,582	666,956
1890	3,012,414	2,702,092	600,131	819,062
1891	3,632,209	3,137,012	1,150,569	1,052,308
1892	3,773,021	3,503,260	1,141,430	942,154
1893	4,099,112	3,815,280	1,255,956	1,129,397
1894	3,650,971	5,059,025	1,655,532	927,220
1895	4,399,623	4,044,998	1,550,256	1,125,601
1896	4,650,455	4,608,113	1,743,590	1,245,012
1897	4,921,701	4,859,373	2,074,663	1,425,026
1898	5,947,272	5,521,160	2,525,294	1,531,562
1899	6,544,956	6,033,344	3,374,183	1,786,009
1900	7,804,879	6,901,637	4,187,630	1,999,797
1901	8,427,574	6,736,107	5,174,160	1,856,677
1902	7,089,805	7,431,687	5,463,791	2,581,218
1903	9,843,063	8,319,775	5,638,337	2,229,065
1904	11,429,403	10,858,159	7,937,845	1,858,197
1905	13,474,282	13,378,468	8,491,465	1,878,279
1906	14,953,677	14,621,316	10,686,659	2,158,005
1907	16,183,511	16,779,893	11,530,728	2,276,342
1908	14,496,967	15,154,204	9,581,436	1,893,725
1909	18,521,107	19,639,106	10,458,132	2,240,573

[a] Includes Clay, Fayette, Kanawha, Nicholas, Putnam, and Raleigh counties.
[b] Includes Logan, McDowell, Mercer, and Mingo counties, and Tazewell County, Va.
[c] Includes Barbour, Harrison, Marion, Monongalia, Preston, and Taylor counties.
[d] Includes Grant, Mineral, and Tucker counties.

The statistics of coal production in West Virginia since 1863, when the State was formed out of Virginia, to the close of 1909, are shown in the following table:

Production of coal in West Virginia from 1863 to the close of 1909, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1863	444,648	1876	896,000	1889	6,231,880	1902	24,570,826
1864	454,888	1877	1,120,000	1890	7,394,654	1903	29,337,241
1865	487,897	1878	1,120,000	1891	9,220,665	1904	32,406,752
1866	512,068	1879	1,400,000	1892	9,738,755	1905	37,791,580
1867	589,360	1880	1,829,844	1893	10,708,578	1906	43,290,350
1868	609,227	1881	1,680,000	1894	11,627,757	1907	48,091,583
1869	603,148	1882	2,240,000	1895	11,387,961	1908	41,897,843
1870	608,878	1883	2,335,833	1896	12,876,296	1909	51,849,220
1871	618,830	1884	3,360,000	1897	14,248,159		
1872	700,000	1885	3,369,062	1898	16,700,999	Total	527,945,602
1873	1,000,000	1886	4,005,796	1899	19,252,995		
1874	1,120,000	1887	4,881,620	1900	22,647,207		
1875	1,120,000	1888	5,498,800	1901	24,068,402		

WYOMING.

Total production in 1909, 6,393,109 short tons; spot value, $9,896,848.

Wyoming's recovery from the business depression of 1908 was exhibited by an increase of 903,207 short tons in the production of coal, from 5,489,902 short tons in 1908 to 6,393,109 tons in 1909. The previous high record of 6,252,990 short tons in 1907 was exceeded by the production of 1909 by 140,119 short tons. The increased production in 1909 was, however, at a sacrifice in price, for while the aggregate value of 1909 production exceeded that of 1908 or 1907, the average price was less than in 1907. Compared with 1908 the total value showed a gain of $1,028,691, or 11.6 per cent, in 1909, and the percentage of increase in production was 16. The average price per ton in 1909 was $1.55, against $1.62 in 1908 and $1.56 in 1907, most of the decline in 1909 being due to a marked falling off in the value of Sheridan County's product, whose production increased over 130,000 tons with a decrease in value of over $50,000. In Sweetwater County the average price declined from $1.69 to $1.61; in Uinta County a slight advance in price was made.

The increased production in 1909 was general throughout the State, there being only one county, Converse, that did not show a gain and in this neither the output nor the decrease was of any significance. The largest gain was in the production of Sweetwater, the leading coal-producing county, whose output increased 460,927 short tons, from 2,180,933 short tons in 1908 to 2,641,860 short tons in 1909. Uinta County increased 205,832 tons, and Sheridan County 130,632 tons. These three counties produce over 80 per cent of the total coal output of the State.

Of the total production of 6,393,109 short tons in 1909, 1,430,551 short tons, or 22.4 per cent, were undercut by the use of mining machines. In 1908, 1,072,619 short tons, or 19.54 per cent, were machine mined. The machines in use in 1909 included 85 punchers, 38 chain-breast, and 4 long-wall machines, a total of 127, against a total of 88 in 1908.

The casualty record in the coal mines of Wyoming as reported by the mine inspectors included a total of 130 accidents, of which 24 were fatal and 106 nonfatal. Of the 24 fatalities, 17 were due to falls of roof and coal, 2 to powder explosions, and 4 to being crushed by mine cars. There was no explosion of gas or dust reported in 1909; in 1908 there were 59 men killed in two explosions on the same day at the Hanna No. 1 mine, the second explosion occurring when rescue parties were at work endeavoring to recover the dead bodies caused by the first. The second explosion killed more than twice as many as the first.

Not a single strike, suspension, or lockout was reported in 1909.

The statistics of production, by counties, in 1908 and 1909, with the distribution of the production for consumption, are shown in the following table:

Coal production of Wyoming in 1908 and 1909, by counties, in short tons.

1908.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Bighorn	91,000	7,475	2,800	101,275	$174,860	$1.73	214	241
Sheridan	784,141	18,597	36,795	839,533	1,276,649	1.52	172	1,165
Sweetwater	2,093,244	11,903	75,786	2,180,933	3,692,267	1.69	226	2,749
Uinta	1,263,577	18,966	97,945	1,380,488	2,035,821	1.47	224	1,547
Other counties[a]	918,336	18,677	49,726	986,739	1,686,325	1.71	233	1,213
Small mines	....	934	....	934	2,235	2.39	....	....
Total	5,150,298	76,552	263,052	5,489,902	8,868,157	1.62	217	6,915

1909.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Bighorn	121,875	7,014	4,500	133,389	$235,080	$1.76	....	....
Sheridan	914,546	21,909	33,710	970,165	1,228,886	1.27	....	....
Sweetwater	2,541,114	14,165	86,581	2,641,860	4,252,719	1.61	....	....
Uinta	1,465,473	13,880	106,967	1,586,320	2,421,008	1.53	....	....
Other counties[b]	984,895	19,161	49,731	1,053,787	1,746,279	1.66	....	....
Small mines	....	7,588	....	7,588	12,876	1.70	....	....
Total	6,027,903	83,717	281,489	6,393,109	9,896,848	1.55	....	7,123

[a] Carbon, Converse, Crook, Fremont, Johnson, and Weston.
[b] Carbon, Converse, Crook, Fremont, Johnson, Park, and Weston.

The statistics of the production of coal, by counties, during the last five years, with increase and decrease in 1909 as compared with 1908, are shown in the following table:

Coal production of Wyoming, 1905–1909, by counties, in short tons.

County.	1905.	1906.	1907.	1908.	1909.	Increase (+) or decrease (−), 1909.
Bighorn	4,605	4,743	56,966	101,275	133,389	+ 32,114
Carbon	354,358	450,636	583,402	543,009	590,969	+ 47,960
Converse	64,939	69,495	48,700	32,745	16,885	− 15,860
Sheridan	742,314	1,014,318	1,226,221	839,533	970,165	+ 130,632
Sweetwater	2,113,979	2,121,546	2,071,842	2,180,933	2,641,860	+ 460,927
Uinta	1,897,668	2,078,772	1,889,742	1,380,488	1,586,320	+ 205,832
Weston	409,690	379,990	361,015	337,815	354,182	+ 16,367
Crook, Fremont, Johnson, Natrona	11,798	[a] 12,929	[b] 14,362	[b] 73,170	[c] 91,751	+ 18,581
Small mines	2,670	1,565	740	934	7,588	+ 6,654
Total	5,602,021	6,133,994	6,252,990	5,489,902	6,393,109	+ 903,207
Total value	$7,336,951	$8,013,528	$9,732,668	$8,868,157	$9,896,848	+$1,028,691

[a] Crook and Johnson only.
[b] Crook, Fremont, and Johnson.
[c] Crook, Fremont, Johnson, and Park.

The first production of coal in Wyoming was reported in 1865, one year later than the first reported output of coal in Colorado. This pioneer coal mining was probably carried on in connection with the construction of the Union Pacific Railroad. The total output in that year amounted to 800 tons. Five years later, when the railroad was completed, the production amounted to about 50,000 tons.

The growth of the coal-mining industry, indicating as it does the increase in population and in the industrial development of the State since 1865 and up to the close of 1909, is shown in the following table:

Production of coal in Wyoming from 1865 to 1909, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1865	800	1877	342,853	1889	1,388,947	1901	4,485,374
1866	2,500	1878	333,200	1890	1,870,366	1902	4,429,491
1867	5,000	1879	400,991	1891	2,327,841	1903	4,635,293
1868	6,925	1880	589,595	1892	2,503,839	1904	5,178,556
1869	49,382	1881	420,000	1893	2,439,311	1905	5,602,021
1870	50,000	1882	707,764	1894	2,417,463	1906	6,133,994
1871	147,328	1883	779,689	1895	2,246,911	1907	6,252,990
1872	221,745	1884	902,620	1896	2,229,624	1908	5,489,902
1873	259,700	1885	807,328	1897	2,597,886	1909	6,393,109
1874	219,061	1886	829,355	1898	2,863,812		
1875	300,808	1887	1,170,318	1899	3,837,392	Total	89,701,776
1876	334,550	1888	1,481,540	1900	4,014,602		

COAL BRIQUETTING IN 1909.

By Edward W. Parker.

PRODUCTION.

Reckoned upon a percentage basis, there was a marked increase in the production of manufactured or briquetted fuel in the United States in 1909, compared with the preceding year. This adjunct to the coal-mining industry in the United States must still, however, be considered in its infancy when compared with the development shown in European countries. The quantity of compressed or briquetted fuel made in the United States in 1909 amounted to 139,661 short tons, valued at the works at $452,697. This was an increase over 1908 of 49,303 short tons, or 54.56 per cent in quantity, and of $129,640, or 40.13 per cent, in value. When this domestic output of briquets, however, is compared with the 17,000,000 or 18,000,000 tons manufactured in Germany, it appears insignificant; but it does show that the industry after many years of trial and discouragement is getting started.

There were 16 plants in the United States which manufactured compressed fuel in 1909, but 5 of them were operated in an experimental way only, and 2 of these 5 manufactured briquets from peat. The different manufacturers place their product on the market under special names, such as "boulets," "eggettes," "carbonets," "patent fuel," "coalettes," etc., but are all included under the general term of "briquets."

The successful operation of a briquetting plant must depend upon its ability to utilize one or more of several classes of low-grade fuel and to produce an article which will compete in efficiency and price with raw or unmanufactured coal or with coke. When comparisons are drawn between the extensive development of the briquetting industry in Europe and the small beginning in this country, it must be remembered that in foreign countries the raw fuel is relatively high priced. In Germany, where the briquetting industry has been most highly developed, the raw fuel is not only more expensive, but also of lower grade than that of the United States. Labor is less expensive in European countries, and, moreover, the wasteful type of coke oven known as the "bee-hive" is now practically unknown. Coal is coked in retort ovens, and nearly all of these are supplied with by-product recovery equipment, which makes available a large supply of coal-tar pitch for binding material. These conditions are all favorable to the successful operation of briquetting plants.

In the United States the industry is held back (1) by the large supply of cheap fuel, (2) by the higher cost of labor, which necessitates a higher price for the manufactured fuel, (3) by attempts, which have not yet ceased, to exploit secret processes for which extraordinary claims are made but which have not proved successful in commercial operation. If the by-product recovery coke processes had made more advances in the United States there would doubtless be available for binders a large supply of coal-tar pitch at prices which would induce the investment of more capital in the manufacture of briquetted fuel. There is an abundant supply of raw material which can be used for briquets, and in the utilization of which one of the greatest steps in the practical application of conservation principles could be made. This consists of materials which unless used in this way are wasted. The classes of low-grade fuel available for this purpose are: (1) anthracite culm; (2) slack coal from semianthracite, bituminous, and subbituminous coal mines, which does not possess fusing or coking qualities, and is therefore not available for the manufacture of coke; (3) lignite, which disintegrates on exposure to air, will not stand transportation to distant points, and can not be stored for any length of time; (4) coke breeze, which possesses high fuel efficiency, but which, because of its small size, can not be used as such either for domestic or other fuel; and (5) peat, which usually occurs at long distances from the coal supplies, and which, if properly prepared, makes an excellent fuel. The utilization of slack from bituminous coal which possesses coking qualities does not enter into the problem, as it can be and is used for making coke and can be used satisfactorily under boilers. A large quantity of powdered fuel is consumed each year in the manufacture of cement, for which even the lowest-grade fuels can be satisfactorily used. This consumption is growing rapidly, with the phenomenal advance in the manufacture and use of cement and concrete, but it is not enough to take care of the enormous quantities of slack produced in the noncoking coal regions, which is in many cases burned to keep it from "cumbering the ground."

The utilization of coke breeze for briquetting purposes presents a problem distinctly its own—that is, the destructive abrasive effect which it has on the crushing apparatus and bearings of the machinery. It has been truly said that this material "cuts like the diamond," and the repair and replacement of parts of the machinery makes an expensive item in the attempts which have been made to use coke breeze in the manufacture of briquets. Two of the briquetting plants built in the United States have been for the purpose, primarily, of utilizing coke breeze. It is the custom to mix the breeze with some bituminous slack or anthracite culm, and it is found that such a mixture makes a more satisfactory briquet. The quantity of this coke breeze produced in the United States each year and practically wasted at the present time is from 2,000,000 to 3,000,000 tons.

In the writer's opinion there is absolutely no reason for secrecy with regard to the constituents of patented binders. The field to be developed is so large that there is room for everyone, provided the expense is not inhibitive and the resultant briquet is a satisfactory fuel. The better educated the public becomes in the use of briquetted fuel the more rapidly will the industry develop, the most pronounced retarding element being the tendency to exploit secret methods of questionable merit instead of progressing along conservative lines in paths laid out by the experience of European countries.

The production of briquets in the United States during the last three years has been as follows:

Production of briquets in the United States in 1907, 1908, and 1909, in short tons.

Year.	Quantity.	Value.
1907	66,524	$258,426
1908	90,358	323,057
1909	139,661	452,697
Total	296,543	1,034,180

In order to meet with popular favor in this country briquets must be of a convenient shape for shoveling and for the circulation of air in the fire box. They must be of suitable sizes for the purposes they are intended to serve, and must possess sufficient cohesion to resist fracture and abrasion under rough handling. The very large briquets made in European countries, particularly in Germany, the chief reason for which is the advantage for stowage in bunkers of steamships and tenders of locomotives, are not adapted for use in this country. They must be handled and stowed by hand, and must be broken up before being shoveled into the fire. Labor conditions in this country make the cost of such handling prohibitive.

Binders.—Experience in European countries and the investigations which have been carried on in the fuel-testing plant of the United States Geological Survey have demonstrated clearly that the successful briquetting of lignite may be accomplished without the use of any additional binding material, and that for the anthracite, semianthracite, bituminous, and subbituminous coals the most satisfactory binders are coal-tar pitch, gas-tar pitch, and asphaltic pitch, or inexpensive mixtures of which one or more of these are the principal constituents. The plants in successful operation in this country at the present time have added their experience to the evidence on this point. One plant began operating in 1910, using a binder of which oil obtained from the distillation of wood is one of the constituents, with apparently satisfactory results. Inorganic binders, though efficient in cementing quality, have the serious objection of adding to the ash but of adding nothing to the combustible character of the fuel. Pitch binders, on the other hand, contribute combustible material and do not increase the ash.

Considerable attention has been given recently in Europe to the possibilities of sulphite pitch as a binder in the manufacture of briquets. The following statement regarding sulphite pitch is extracted from a report made by United States Consul George Eugene Eager, of Barmen, Germany:

The material is obtained in the process of manufacturing sulphite cellulose. The wood is put through a washing process in lye by which the fiber, being pressed out from the wood pulp, is cleared of all resinous ingredients. Thus far this material has been entirely useless. Through a cooking process it is reduced to a highly glutinous substance called "sulphite pitch," which is intensely glutinous and possesses a high binding power. In the ordinary briquet of bituminous coal from 7 to 10 per cent of coal tar is used to give it the proper hardness, and with the use of sulphite pitch the same results can be obtained by the use of 5 per cent. There are qualities of coal that can easily be briquetted with from 2 to 3 per cent of the sulphite pitch.

Sulphite pitch does not soften under heat and burns at a high temperature. It can be ground to any consistency or can be produced directly in any form of powder; it can be had in every country where there are cellulose mills, and it is very cheap.

Recent trials to briquet coke gravel and dross, the remainder of coke (hitherto useless), show a briquet that can be considered a perfect substitute for coke. Practical trials of these briquets in both blast and cupola furnaces have shown that the briquets do not fall to pieces even under the highest temperature, but burn while gradually shrinking. On account of their consistence they enter deeply into the melting zone of the furnace, thereby contributing materially to the melting effect. Fine ore, bog-iron ore, brown ore, mangan ore, oxide, furnace cadmia, iron dust from blast furnaces, and other ores can all be briquetted by the use of sulphite pitch and successfully melted in the furnace.

It is true that sulphite pitch can be dissolved in water, and that briquets made from it are not waterproof; the sulphite-pitch briquet is, however, more waterproof than the lignite briquet, the making of which has become a flourishing industry. The sulphite briquet is not hygroscopic, and can be made waterproof if it is necessary by simple special treatment.

One of the latest uses to which it has proved successful is as a dust layer for roads. Sulphite pitch was dissolved with water to a certain consistency and sprayed over the roads, and such a dressing was sufficient to prevent dust arising for at least six weeks. This method of dust laying is much preferable to the use of oil or tar, is much less expensive, has no odor, and does not destroy vegetation.

BRIQUETTING PLANTS OF THE UNITED STATES IN 1909.

The following briquetting plants, which have been described in Geological Survey Bulletin No. 316 or in previous volumes of Mineral Resources of the United States, were not in operation in 1909: Standard Fuel Company, Birmingham, Ala.; Arizona Copper Company, Clifton, Ariz.; Western Fuel Company, Oakland, Cal.; Pittsburg Coal Mining Company, Pittsburg Landing, Cal.; San Francisco and San Joaquin Coal Company, San Francisco, Cal.

New Staunton Coal Company, Livingston, Ill.—As originally designed this plant was intended primarily to test the practicability and efficiency of a process invented and patented by Gustav Komorek and controlled by the Rutledge & Taylor Coal Company, of St. Louis, Mo. It is known as the Rutledge press. The plant as at first constructed contained only such equipment and machinery as was necessary to operate the press intermittently, the materials being measured and fed by hand. This method served to establish the ability of the press to make briquets, but it did not indicate what the press would do under continuous operation in a commercial plant.

The designing and construction of the remainder of the plant and placing it on a basis of continuous operation were intrusted to the Roberts & Schaefer Company, of Chicago, and the following description has been furnished by Mr. Charles T. Malcolmson, briquetting engineer for the Roberts & Schaefer Company:

The New Staunton plant consists essentially of a flight conveyor which brings the coal direct from the tipple to a 100-ton storage bin for fine coal. At a point directly above this bin a rotary screen is installed and the fines passing through the screen are of the proper size for the most economical briquetting mixture. The oversize from this screen passes through a grinder and the ground material is delivered to the bin. The sized coal is delivered to a Trump measuring machine by means of an automatic feed which is under the control of the operator, and is set according to the requirements of the press.

The binder, coal-tar pitch, is delivered to the briquetting plant in bulk and unloaded on a platform located between the tipple and the briquetting plant. This platform is protected from the weather by a fireproof roof. Extra supply of pitch is carried in barrels and delivered to the main storage platform on a tram car built for that purpose.

The bulk pitch is broken up on the platform, weighed on platform scales, and fed into the pitch cracker by hand. The pulverized pitch is delivered to the mixing and feeding apparatus in the briquet building by means of a belt conveyor. In order to insure an intimate mixture of the pitch and coal, the pitch is mixed with a small percentage of coal and ground very fine in a pulverizer. The design of this equipment has been worked out with a great deal of care and is the result of considerable experience in the handling of briquetting pitch. Fireproof equipment is used throughout in the installation necessary to accomplish the pulverizing and handling of this binder.

The finely divided binding mixture is delivered by an elevator to a small steel hopper from which it is fed to the Trump measuring machine directly underneath. The Trump machine delivers the correct proportions of binder and coal to a long horizontal conveying mixer which thoroughly mixes the raw materials, and delivers the product to a boot of the elevator which in turn carries the mixture to the heaters or "malaxeurs."

With very few exceptions the capacity of briquetting plants which have operated successfully even for a short time in this country has not exceeded 10 tons per hour. It is not surprising that this low tonnage should mark the maximum capacity of the earlier plants since it compares favorably with the capacity of European presses making briquets of approximately the same size as those used in this country. The adoption of the briquetting industry in the United States brought also the use of the methods employed in Europe for handling raw materials and finished product, and as long as the capacity did not exceed 8 or 10 tons per hour, these methods in the main were satisfactory. When, however, the capacity of the machine is increased three or four times the briquetting problem changes radically and the conditions met in the smaller plants give little indication of what is necessary in handling the larger capacity.

Particularly is this true in the equipment for heating the mixture. It was necessary, therefore, for the inventors and designers of the Rutledge press to design also a heater which would handle form 30 to 50 tons of material per hour and bring it to the proper temperature and mass consistency without the use of an undue quantity of steam. The Rutledge heater has accomplished this end and is one of the features which makes for the success of the New Staunton plant.

The Rutledge press is a departure in principle from any other press exploited in this country, and does not follow the practice of any European press in actual operation to-day. It seeks to combine the efficiency of the plunger type with the capacity of the rotary or Belgian type of press. This is accomplished by the use of a continuous mold into which the plungers enter at right angles with the movement of the dies, compress the briquets, and leave the dies in the same manner. The plungers are carried on steel grids; and for the part of the revolution during which the compression is made, the direction of the plunger is rotated on the seat of the grids, so that its angularity is constantly corrected to a straight line motion.

It would appear that the necessity of changing the direction of the plunger during the compression period would throw an enormous strain on the mechanism, since the pressure used in making briquets exceeds 2,500 pounds per square inch. To the initiated, however, it is well known that the actual heavy load in making briquets occurs during a very small fraction of the compression at the end of the stroke. This means that in a press the size of the Rutledge press, the angle of rotation of the plunger during the heavy pressure period is so small as to be practically negligible.

To insure positive alignment two pilot punches are installed on each set of dies and plungers, so that from a period just before the punches enter the dies to the same relative period after the punches leave the dies, the punch head and the die housing are effectually locked so that their movement is synchronized. These pilot punches relieve all strain in cams and arms which correct the angularity of the punches and also insure the positive entering of the punches into the dies without any wear on the punch ends.

The dies forming the continuous mold pass between two sets of plungers, so that the compression is made equally on both sides of the briquet. The amount of compression is determined by relief springs above the bearings of the upper set of punches. The lower set of punches eject the briquets from the dies at a point directly underneath the main shaft.

The material from the heaters is fed into a loading hopper in which there are agitators operating on horizontal shafts. These agitators load the dies uniformly and insure a positive loading of each die. Enough compression takes place during the loading period to hold the material in the dies until the plunger enters.

The capacity of the press at Livingston is 32 tons per hour at 8 revolutions per minute. The speed of the press is determined by the maximum travel allowable for the mold table, which is attained at 10 revolutions of the press. The briquets are cylindrical in shape with spherical ends 3¼ inches in diameter, are about 3 inches thick, and weigh 16 ounces. The warm briquets from the press are ejected directly on a grizzley from which they slide to the cooling belt. Waste material coming from the press passes through this bar screen to a screw conveyor underneath, which delivers it to the mixing conveyor described above.

The cooling belt consists essentially of a steel-woven wire belt 250 feet between centers and of the proper width, so that the briquets remain on this belt a sufficient time to allow them to cool. This belt delivers the briquets to a 150-ton storage bin containing a "telegraph" for lowering the briquets into the bin with minimum breakage. Briquets are loaded out from the bin by a chute in the same manner that locomotives are coaled and at such a rate that a car can be loaded in about ten minutes.

The machinery in the main briquet building is driven through a line shaft by a 150-horsepower engine. The conveyors, grinders, conveying belts, and other equipment outside this building are driven by motors, the current for which is supplied by a direct-connected 75-kilowatt generating set. Two boilers of 150-horsepower capacity furnish the steam, and in one of these boilers is installed a superheater which furnishes the superheated steam to the "malaxeurs" and the generating set.

Care has been taken to maintain a uniform mixture since the quantity of pitch necessary to make good briquets must be reduced to a minimum. This is essential in any plant where the difference between the selling prices of the slack and the lump coal allows such small margin for briquetting.

The fine cuttings from the coal-mining machines which are hoisted separately from the mine and such of the fine coal from the screenings as is necessary to make up the total requirement of the briquetting plant are used in making the briquets at Livingston. Six and a half per cent of pitch is used to make marketable briquets from this coal, and the fuel finds a ready market in St. Louis and in the western States, notably Kansas, Iowa, and Nebraska. The briquets are slightly higher in ash than lump coal, but give excellent satisfaction for both domestic and steam purposes. The railroads which buy coal from the Staunton Coal Company are always ready to take briquets no the same basis, since the briquets show a greater evaporative efficiency than the lump coal, and the ability of the briquets to withstand the action of the weather when stored in the open is also in their favor.

Briquet Coal Company, Murphysboro, Ill.—The machinery installed at this plant was brought from Stapleton, Staten Island, the location of the latter place having been found unsuitable for the receipt of raw material and for the shipment of the briquets. The Staten Island plant was described in Geological Survey Bulletin 316. At Staten Island the plant was designed to utilize anthracite culm with a coal-tar pitch binder; at Murphysboro it will use slack coal from shaft No. 9 of the Big Muddy Coal and Iron Company, the briquetting plant being located convenient to the tipple. The character of the binder to be used has not been decided upon. It will probably be either coal-tar pitch or water-gas pitch. It is anticipated that the plant will be ready for operation some time during the summer of 1910. The present plant is substantially constructed, all of the floors and foundations being of concrete. Wash rooms and shower baths are provided for the employees. The buildings are of corrugated galvanized iron. The two presses are of foreign make, one of them of Couffinhal type, built by Schuchterman & Kremer, of Dortmund, Germany; the other press of the Belgian type, built by H. Stevens, Charleroi, Belgium. The slack coal to be used is conveyed from the tipple to a chute through which it passes to a Ruggles drier. After being thoroughly dried it is elevated in a bucket conveyor to a Williams-type mill where it is reduced to "dust." The dust is elevated to a bin from which it is drawn into a Trump measuring machine where it mixes with a binder. It is then elevated by bucket conveyor to the heating and mixing tank and thence through the presses. The heat is applied direct. The briquets from the German press are parallelopiped in shape, with the end edges rounded. The dimensions are $4\frac{3}{4}$ by $2\frac{1}{4}$ by $2\frac{1}{2}$ inches, and the briquets weigh about $1\frac{1}{2}$ pounds each. The product of the Belgian press is of the eggette pattern, the briquets weighing about 5 ounces each. The capacity of the German press is $4\frac{1}{2}$ tons and that of the Belgian press $7\frac{1}{2}$ tons per hour.

Indianapolis Pressed Fuel Company, Indianapolis, Ind.—This company began operations on November 15, 1908, at the corner of State and Deloss streets, Indianapolis. The press, which is the invention of Mr. George W. Ladley, secretary and treasurer of the company, makes a cylindrical briquet weighing about 9 ounces. The material employed is the slack from Indiana coal with coal-tar pitch as a binder, the proportions being 95 per cent slack and 5 per cent pitch. In addition to operating on a commercial scale for the local trade of Indianapolis, the plant has been used for making experimental runs on anthracite culm, subbituminous coal, coke breeze, and lignite. During 1909 the company added to its equipment a heating machine through which the slack is passed as it is unloaded from the cars. It is subjected to a temperature of about 900° F., the object being to drive off some of the volatile constituents and decrease the quantity of smoke in the burning of the briquets. This also increases the friability of the coal and makes it more readily pulverable. The slack is ground to about the size of coarse corn meal, the pitch being ground separately. Both coal and pitch are automatically measured so that the exact percentage of each may be obtained. They are mixed cold and from the mixing machine the mixture is elevated by bucket conveyor to the heater, through which it passes in a continuous stream, two and one-half minutes being required for the heating. The capacity of the briquetting machine is 16 tons per hour.

Fertile Clay and Peat Company, Fertile, Iowa.—As indicated by the title, this company is organized for the purpose of briquetting peat. During 1909 the plant produced about 200 tons of peat briquets weighing about 2 pounds each, no binding material being employed. The briquets are used for household purposes, for steam boilers, and by the company itself.

Lexington Peat Company, Boston, Mass.—This is also a peat briquetting company, the location of its plant being at East Lexington, Mass. It began operations in October, 1909, and produced a small quantity of peat briquets during the remainder of the year. The briquets are cylindrical in shape, weighing 2 ounces each, and are intended for household use. As reported to the Geological Survey, the briquets are made with the use of a coal-tar pitch binder in proportions of about 90 per cent of peat and 10 per cent of binder. The peat is heated before being mixed with the pitch, the Mashek mixing machine being used. The peat is first dried in a rotary drier and fed to a mixing machine, where the binder is introduced; it then passes to the press which is a 6-plunger machine, making 24 briquets for each revolution and running 40 revolutions per minute. The plant is regarded at present as only experimental.

Detroit Coalette Fuel Company, Detroit, Mich.—The briquetting plant of this company is located at the corner of Seventeenth street and Hancock avenue in the city of Detroit. It began operations on July 1, 1909. The plant is operated on Pocahontas slack, using 93.5 per cent slack and 6.5 per cent coal-tar pitch. The Renfrow press is used, producing cylindrical briquets or "coalettes," with convex ends, which weigh approximately 13 ounces each. They are intended for household use. The following brief description of the plant has been furnished by the company:

Slack arriving in cars is dumped into a concrete hopper beneath the track. From the hopper the coal is fed, by means of a spout, to the boot of an elevator which raises it sufficiently to be fed into a feed bin or to a storage yard beyond the plant. The coal from the bin is conveyed by a belt conveyor to the hopper from which it passes to the pulverizer by a 12-inch beaded flight conveyor, whose cross section is a rectangle. The pitch after preliminary crushing in a pitch cracker is carried by means of a 6-inch flight conveyor and emptied upon the coal in the conveyor. Before reaching the pulverizer the mix passes under strong magnets to remove any pieces of iron which may have accidently been introduced. A simple method of measurement of the coal and pitch is used. Both conveyors are rectangular in cross section and by means of a steel slide to each the area of the smaller is made to admit approximately 6 per cent of the larger. From the pulverizer the material drops into an elevator boot and is conveyed to the heaters, live steam being used. The coalettes are ejected from the press on a 36-inch belt conveyor which is operated at a speed necessary to handle the press output and to permit the coalettes to cool before being dumped. The plant is operated entirely by electricity. In addition to running on the Pocahontas slack, the company has been experimenting with Hocking slack and with wood pitch from charcoal burners.

Semet-Solvay Company, Detroit, Mich.—This plant has already been described in previous reports of this series. It was installed for the purpose of utilizing the coke breeze, an otherwise wasted product of the Semet-Solvay coke ovens. In order to make a satisfactory briquet it has been necessary to mix the coke breeze with about equal quantities of bituminous slack. The average composition of the mix during 1909 was 45.5 per cent bituminous slack and 45.5 coke breeze, with 9 per cent hard coal-tar pitch. The principal difficulty encountered was from the abrasive action of the coke breeze. As originally designed the plant consisted of a Johnson (English) briquetting machine, but the product was not suited to the market. The press now in use is a French design made by the Société Nouvelle des Etablissements de l'Horme et de la Buire, using chrome steel tires. The materials are measured in the Trump measuring machine and are mixed cold, pulverized in a Williams-type mill, and heated by steam in pug mills. The briquets are intended for household consumption.

Standard Briquet Fuel Company, Kansas City, Mo.—The location of this plant is at Twelfth street and Elmwood avenue, on the outskirts of Kansas City. It was constructed under the supervision of the Roberts & Schaefer Company, of Chicago, and was put in operation on December 1, 1909. The operations during the year may be considered, therefore, as largely experimental, although the product was something over 1,000 tons. The capacity of the press is 7½ tons per hour. The briquets are of the same shape as those produced by the Renfrow press—cylindrical with convex ends—and weigh approximately 16 ounces. They are intended for general domestic use, but particularly in house-heating furnaces. Since January 1, 1910, the plant has been operated with double shifts of ten hours each, and has produced 150 tons daily. Forty per cent of the product is sold locally in competition with natural gas, and 60 per cent is shipped to adjacent points in Missouri, Kansas, and Nebraska. The material used is Arkansas semianthracite screenings and coal-tar pitch in the proportion of from 94 to 95 per cent screenings and from 5 to 6 per cent pitch. The following description of the plant is from an article by

Mr. C. T. Malcolmson, briquetting engineer for the Roberts & Schaefer Company, published in the technical press:

If the raw coal arrives at the plant without having encountered a rain or snow storm in transit, it is taken directly to the raw coal bin from the car unloader by means of a steel flight conveyor. If it is desirable to take this coal directly to the briquet-machine building a gate in this conveyor discharges the coal on a belt conveyor provided for that purpose.

Should the coal be wet or covered with snow or ice, it is by-passed directly from the car unloader to a rotary drier which has been installed for this purpose and is of ample capacity for the needs of the plant. The coal discharged from the drier is taken to the top of the raw coal bin by a steel-lined bucket elevator, where it is discharged either into the bin or on the belt conveyor previously mentioned. The raw coal bin is built of wood, lined with steel, and has a capacity of 200 tons. A spout at the bottom allows the coal to be drawn into the boot of the bucket elevator serving the drier, so that if for any reason it is desirable to turn over the stored slack, it can be run out of the bin and in again.

The raw coal is brought to the briquet-machine building on a conveying belt and discharged into a hoppered storage bin inside the building. This bin is made dust tight and steel lined. To the bottom of this bin is attached an automatic scale weighing 200 pounds at a time and registering each hopperful as it is discharged. Thus at any time the operator can read directly in tenths of a ton the amount of coal passed through the plant. This scale discharges into a closed hopper. When the hopper is full the coal prevents the swinging bottom of the scale from operating so that the whole process becomes automatic.

All of the equipment used from the time the coal and pitch are brought together until the briquets are made is absolutely dust tight. A further precaution was also found necessary in the installation of an exhaust system, including a fan and dust collector.

The binder used at this plant is pitch made from the distillation of coke-oven tar. The hardness desired is that which will allow it to be handled and shipped in bulk on the hottest days, and yet not so hard that a noticeable percentage of the heavy oils is taken out.

The pitch is shipped in open or box cars, and is unloaded on a concrete platform at the rear of the briquet-machine building. This platform is surrounded by a bulkhead 4 feet high and is capable of holding 120 tons of pitch. Located about centrally on this platform is the pitch "cracker" or grinder, a specially designed mill, which breaks down the pitch with a minimum of dust. The mill is fed by hand from a wheelbarrow of pitch previously weighed, and the ground pitch is taken to the charging floor in the briquet-machine building by means of a belt conveyor. The belt and crusher are housed and the "pitch handler" is protected from the weather. Adjacent to this pitch platform is space sufficient for the storage of 200 tons of pitch in barrels, which is carried on hand as a reserve stock.

The fine, thoroughly mixed, and dry material is delivered to a vertical cylinder or "heater" of the briquetting press. In this cylinder is a vertical shaft with arms which agitate the mass and stir it while it is being heated and fluxed by the steam admitted through the walls of the cylinder near the bottom. This steam is superheated and the temperature is varied according to requirements. The cylinder is provided with a ventilating pipe to carry off the excess steam. The fluxed mass is discharged through a gate to the "feed box" of the press, where, by means of an agitator, the mass is cooled and the dies are filled. The Misner press is of the Couffinhal type, a type well established in Europe, which undoubtedly owes its popularity there to its efficient work, simplicity of design, and accessibility of parts. The die table rotates horizontally, making one-quarter of a turn at each revolution of the press or compression of briquets. There are four sets of dies of 20 each in the die table, which moves under the feed box between the compressing plungers and under the ejecting plungers. Thus, at any given moment, there is one set of dies being filled, one being compressed, one in transit, and one being ejected. The table is moved by an arm actuated by a cam; it is locked each time before the plungers enter the dies. A double compression is obtained by two bell-crank toggles driven from a crank shaft, which in turn is actuated by a train of gears. The locking device, cam for moving the table, and cranks for the toggles are all on the same shaft, thus insuring perfect alignment. A pressure of 2,500 pounds per square inch is obtained on the briquets. The briquets are $3\frac{1}{4}$ inches in diameter, about 3 inches thick, and weigh 16 ounces. On one end the letter S is stamped. The press operates at slightly over 12 revolutions per minute, giving a capacity of $7\frac{1}{2}$ tons per hour.

The ejected briquets fall on an inclined bar screen, which discharges them to the coaling belt conveyor. This conveyor is of woven steel wire and runs direct from the press to the storage bin for briquets. It delivers the briquets at the discharging end at such a speed that the briquets have time to cool and can be handled mechanically.

The United States Fuel Briquette Company, Deer Lodge, Mont.—This company was organized for the purpose of briquetting lignite. The only work done in 1909 was a small amount of an experimental character.

New Jersey Briquetting Company, Perth Amboy, N. J.—As noted in the report for 1908, this plant was removed from Brooklyn, N. Y., to Perth Amboy, N. J., and is operating under the Zwoyer briquetting process. The location of the plant at Perth Amboy permits a much better mechanical arrangement, although the anthracite culm has to be transshipped in order to reach the plant, and the briquets have to be shipped to the market at a disadvantage. The plant was put in operation at Perth Amboy in November, 1908. During 1909 it was operated principally on Lykens Valley anthracite culm, with a proportion of 90 per cent of culm to 10 per cent of coal-tar pitch. The pitch is introduced hot, the coal being subjected to a preliminary heating to the same temperature as that of the pitch. The briquets are of the pillow-shape pattern, weigh about 2 ounces each, and are for household purposes. The average running capacity of the machine is 16 tons per hour, but it has been operated at a maximum of 22 tons.

Economy Coal Company, 227 Fifth avenue, New York, N. Y.—This is a corporation organized for the purpose of manufacturing briquets, using a binder the exact constituents of which are not given, but whose principle involves the use of a small quantity of cement with an admixture of oil obtained from the distillation of wood. The company has secured possession of the briquetting plant of the D. Grieme Coal Company, at the foot of West Forty-seventh street, New York, and has made numerous changes and improvements in the arrangement and in the mechanical operation of the plant. The company did not manufacture any briquets during 1909, but the plant was operated for a short time during the year by the D. Grieme Coal Company, which turned out something over 200 tons of briquets.

The operation is one in which no heating of the mixture is required, although the coal is passed through a drier in order to remove any superfluous moisture. The coal used is anthracite culm, which is mixed with the binder in the proportion of 90 per cent of culm to 10 per cent of binder. The following result of a test made for the heating efficiency of the briquets as compared with the raw coal from which they were made was furnished by Mr. H. H. Platt, the president of the company: The briquets had been baked in order to make them smokeless and odorless. The test was made in two upright cylinder stoves of the same pattern and of the same draft arrangement. Twenty-eight pounds of briquets were used in one stove and 28 pounds of coal in the other. Two vessels of the same kind, each containing 2 pounds of water, were placed over openings in the tops of the stoves. The water on the stove containing the briquets boiled in four minutes; that on the stove containing anthracite coal boiled in ten minutes. In half an hour of the time of firing the water was again weighed and showed that the briquets had evaporated 1½ pounds of water while the coa had evaporated three-fourths of a pound. The coal fire lasted four hours, the briquet fire five and one-half hours, and the temperature in the two stoves one hour after starting was 550° C. for the coal and 650° C. for the briquets. Neither fire was shaken or otherwise disturbed during the test, and no fuel was added to either fire after the start. A similar test made with baked and unbaked briquets showed that in half an hour baked fuel had evaoprated 2½ pounds of water; the unbaked, 2 pounds. The fire made with the baked briquets lasted six hours and ten minutes, while the fire from the unbaked briquets lasted four hours and forty minutes.

Robert Devillers, Brooklyn, N. Y.—This plant was described in Geological Survey Bulletiin No. 316. It has been in active operation since it started up, April 10, 1907. As at present operated it runs on 95.5 per cent of anthracite culm and 4.5 per cent of coal-tar pitch binder. The capacity of the plant has been doubled by an additional press, both presses being of the Belgian type, producing eggettes weighing approximately 1 ounce each and intended principally for household consumption.

Rock Island Coal Company, Hartshorne, Okla.—This plant was constructed by the Rock Island Coal Company for the purpose of utilizing the slack coal produced at its several mines in Oklahoma. It consists of a Renfrow press and was constructed under the supervision of Mr. Charles T. Malcolmson. It was fully described in Mines and Minerals for March, 1909. The company has given to its product the trade name of "carbonets." The plant was completed and in operation in September, 1908, and was operated actively during the rest of the year. It uses 92 per cent of bituminous coal slack and 8 per cent of water-gas pitch. The briquets weigh about 13½ ounces each, are of cylindrical shape with convex ends, and are intended for household purposes and for use under locomotive and stationary boilers. The machine has a capacity of 8 short tons per hour.

Pacific Coal-Briquette Company, Marshfield, Oreg.—This company has been organized for the purpose of experimenting with Coos Bay, Oreg., subbituminous coal and has done nothing on a commercial scale. The company has installed a press of the German type, and if it proves successful in briquetting Coos Bay coal without a binder a larger plant will be installed.

Scranton Anthracite Briquette Company, Dickson City, Pa.—This plant, located adjacent to the Delaware, Lackawanna and Western Railroad Company's mines near Dickson City, has the largest capacity of all the briquetting plants so far established in the United States, and in 1909 produced more than 50 per cent of the entire output of briquets in this country. During 1908 an additional press was installed, doubling the capacity of the plant, and in 1909 a new power plant was installed. This interfered to some extent with the operation of the plant, which was unable to run at its full capacity. With the additional improvements the plant now has a capacity exceeding 100,000 tons a year.

Brawbaugh Artificial Fuel Company, Harrisburg, Pa.—This company was organized in 1909, but at the close of the year had not selected a location for its plant nor determined upon the equipment to be installed.

The Coal Compress Company, Philadelphia, Pa.—This company during 1909 was operating a small plant in the coal yard of Messrs. Downing Brothers, Thirtieth and Walnut streets, West Philadelphia, for the purpose principally of making a practical demonstration of the briquetting process covered by what is known as the Giles patent. The plant produced between 400 and 500 tons of briquets in 1909, most of which were given away in order to introduce the product. The briquets are of small size and intended for domestic consumption.

Lehigh Coal and Navigation Company, Lansford, Pa.—This plant was constructed by the Lehigh Coal and Navigation Company for the purpose of utilizing the anthracite culm from its own mines. It was started up in May, 1909, but was entirely destroyed by fire in December of the same year. In the six months of run it produced approximately 7,500 tons of briquets containing from 95 to 96 per cent of anthracite culm and from 5 to 6 per cent of coal-tar pitch. The briquets weighed 1.6 ounces, and were of boulet pattern, and the entire production was sold for domestic use. A new plant with a capacity of from 300 to 500 tons is in process of construction and is expected to be completed in 1910. The plant will consist of 4 briquetting presses, together with drying, separating, and cleaning equipment.

United Gas Improvement Company, Point Breeze, Philadelphia, Pa.—This plant has been described in previous reports of this office, and as originally constructed was intended primarily for the purpose of utilizing coke breeze produced at the gas works of the company, the coke breeze being mixed with anthracite culm and bituminous slack. On account of the abrasive action of the coke on the presses and bearings, attempts to utilize the coke breeze appear to have been abandoned, and the plant is now operated upon anthracite fines. The product of the briquetting plant is, however, still used by the company in the manufacture of water gas.

Rhode Island Coal Company, Portsmouth, R. I.—This company, which was organized for the purpose of reopening and operating the anthracite mines at Portsmouth, R. I., has also in contemplation the construction of a briquetting plant, but no progress had been made in that part of the enterprise at the close of 1909.

The Black Diamond Briquette Company, Dallas, Tex.—This company has taken over the business of the Texas Briquette Fuel Company, which is mentioned in the report for 1908 as having been organized for the exploitation of the briquetting process patented by M. Mannewitz. A small quantity—about 200 tons—of briquets were made on an ordinary brick press during 1909, but this plant was burned, and the company is now endeavoring to obtain sufficient capital to rebuild a plant of its own. With Arkansas semianthracite slack available at reasonable prices and with rapidly developing country adjacent to Dallas and Fort Worth, it would appear that conditions favor a briquetting business in that locality.

Washington Coal Briquette Company, Seattle, Wash.—This company was originally organized for the purpose of briquetting the subbituminous coal of Renton, a suburb of Seattle. The promoter of the enterprise was, however, accustomed to dealing with eastern coals and was unfamiliar with the character of the Renton product. Dissensions arose in the company and litigation followed. The company is continuing experimental work but has not begun operations on a commercial scale. It is proposed to use approximately 82 per cent of the Renton subbituminous coal, 10 per cent of bituminous slack, and 8 per cent of binder.

Coal Briquette Machine Company, Oshkosh, Wis.—This company, the organization of which was noted in the reports for 1907 and 1908, did not go into active operation until December 1, 1909, and produced about 150 tons during that month. It contemplated originally the use of anthracite culm, principally, with 4 per cent of coking-coal slack, and 8.25 per cent of coal-tar pitch binder. The company reports, however, that its intention is to operate hereafter on bituminous or semibituminous briquets, as the anthracite briquets are not so well suited to the market. The plant includes a press of the Couffinhal type, adapted to the making of two sizes of briquets, of 10 ounces and $1\frac{3}{4}$ pounds. The capacity of the machine is from 3 to 4 tons per hour.

The Stott Briquette Company, Superior, Wis.—This plant began operations on November 1, 1909, manufactured approximately 4,000 tons of briquets, and was in active operation during the remainder of the year. The material used was anthracite culm and bituminous slack obtained from the coal yards of Duluth, Superior, and other cities along Lake Superior. The plant includes a Mashek press, and the coal-tar pitch used as a binder is melted before being introduced. As in the Zwoyer process, the coal is preheated and the pitch is introduced in mixer No. 4, there being 6 mixers in all. The briquets are of pillow form, weigh $2\frac{1}{4}$ ounces each, and are intended for household consumption. On account of the severe cold which prevails during the winter months in this locality, it is probable that the plant will run in the summer and stock up for the winter trade.

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UNITED STATES GEOLOGICAL SURVEY BRIQUETTING PLANT, PITTSBURG, PA.

By Charles L. Wright.[a]

This plant, which is part of the government fuel-testing plant, was originally started at St. Louis, Mo. It was transferred from there to the Jamestown Exposition Grounds at Norfolk, Va., and after the expiration of the Jamestown Exposition the plant was moved to its present and permanent location at Pittsburg, Pa. The present equipment of this briquetting plant consists of two briquetting machines. One of them is the English briquetting machine used on the tests at Norfolk and St. Louis; the other, a German lignite briquetting press and its equipment, was erected at Pittsburg for the first time. A steel-framed building, with reinforced concrete curtain walls 2 inches thick, was provided for housing the equipment. This plant was put in operation in March, 1909. The equipping of the English machine has not been completed at the Pittsburg plant, although it has been set on a foundation.

The German lignite briquetting equipment is really a plant in itself, and consists of a drier, cooler, press, and conveying apparatus, as well as crushers and elevators. It is typical of the plants used in Germany with great success for briquetting brown coal. The most important parts of this equipment were furnished by the Maschinenfabrik A. G. zu Magdeburg, Germany. The press is of the open-mold type, and is driven by a direct-connected steam engine. The capacity is 2½ to 3 tons per hour, and its speed averages 100 revolutions per minute. One briquet is made at each revolution. The machine develops a pressure of from 14,000 to 28,000 pounds per square inch. This press is only adapted for those varieties of peat and lignite which contain sufficient natural binder to dispense with artificial binders, and it is not suitable for briquetting materials with a binder. The material to be briquetted must be dried to contain not more than 15 per cent and not less than 5 per cent water, the exact percentage necessary varying with the different lignites. Tests were made in the four months of 1909 that the plant was in operation on 7 samples of lignites, 3 of these samples coming from Texas, 3 from North Dakota, and 1 from California. The object of these tests was to determine if American lignites could be briquetted without the use of artificial binder under the same conditions as prevail in Germany for briquetting brown coal. The briquets made were elliptical in one section and rectangular in the others; their dimensions were approximately 6¼ by 2½ by 1 inch, and their average weight was approximately 1

[a] Of the United States Bureau of Mines.

pound. As a result of these tests, it was found that briquets could be made without the use of binding material from the lignites of the three fields investigated. The briquets from California lignite were entirely satisfactory and were strong, would stand handling, and resisted the effects of the weather for several months. The briquets made from the North Dakota lignites were also satisfactory as far as form and strength were concerned, but would not withstand the effects of weather so well as the California lignites. The Texas lignites were briquetted only with considerable difficulty and the briquets obtained were poor in form and weak and did not resist the effects of weather at all. These tests, however, should hardly be considered complete, as some of the samples of Texas lignites were entirely used up before satisfactory results had been reached, although the last briquets made from the sample were much better than those made at first. However, from the results of these tests the indications are that Texas lignites and some samples of North Dakota lignites would require the use of binding material to produce commercial briquets.

These tests proved that the reduction of the moisture in the briquetting process increases the heat value of the briquets obtained from 37 per cent to 54 per cent more than that of the raw fuel. This improvement in heat value will be of great importance to a consumer, as a greater efficiency is obtained from the combustion of fuels of high heat value than from those of lower heat value. The experiments have also conclusively demonstrated that the briquetted fuel withstands the effect of weathering several months longer than the raw fuel. This is due to the fact that the moisture content of the fuel is reduced to a stable condition in the process of briquetting. It is to be hoped that further tests of other lignites of the country may be made on this equipment.

COKE.

By Edward W. Parker.

INTRODUCTION.

As in the preceding reports of this series, the use of the term "coke" in the present chapter is limited to the product obtained by the distillation or partial combustion of certain grades of bituminous coal in retorts or ovens at high temperatures. This product is commonly known as "oven coke." When the process is one of partial combustion, as in the beehive ovens, it is accomplished by the admission into the combustion chamber of a limited supply of air sufficient, supposedly, for the combustion of the hydrocarbons only. It is impossible, however, to effect this result without the combustion of at least a small portion of the fixed carbon, or coke. In retort ovens the mass of coal, usually crushed to one-half inch or smaller, is entirely excluded from the air in chambers approximately 33 feet long, 6 to 8 feet high, and 17 to 22 inches wide, the heat being applied by the combustion of gases distilled from the coal in flues arranged horizontally or vertically between the ovens. The temperature in the coking chamber of either the beehive or the retort oven is usually between 2,500° and 3,000° F., this high temperature being necessary to effect the proper fusing of the mass and its change into the cellular, silvery product known as coke.

The product thus obtained is a fuel suitable for the blast furnace, the foundry, and the smelter, although its use is not restricted to these industries. A considerable portion of the coke manufactured in the United States is crushed in the same manner as anthracite coal, screened, and sold for domestic consumption. It is a smokeless fuel and thus becomes a competitor with anthracite coal in cities where the emission of smoke from the combustion of bituminous coal is prohibited. It also comes into competition with gas-house coke and with both natural and manufactured gas. The coke product resulting from the manufacture of illuminating gas, which is accomplished in retorts in which the process is conducted at much lower temperatures than in the ovens, is not considered in this report.

The United States is much behind European countries in the abandonment of the wasteful beehive method of coke manufacture and still clings to this method, which may well be called antiquated. In Europe, particularly in Germany and Belgium, the beehive oven has passed out of existence. In those countries the retort oven, with or without by-product recovery, is now exclusively used. Where the by-products are not recovered, the surplus heat from the combustion of gases is used in the generation of power, and it is estimated that about 15 horsepower can be obtained from each oven, from which it may be deduced that from approximately 38,000 ovens in the Connellsville and Lower Connellsville districts of Pennsylvania it would be possible to obtain over 500,000 horsepower a year if retort ovens were substituted for beehive ovens.

Prior to 1893 practically all of the coke produced in the United States was made in beehive ovens. No effort was made to recover or utilize the gases and other constituents of the coal. In the early history of the industry the Connellsville district of Pennsylvania was found to produce an ideal blast furnace fuel in the beehive oven, and the example set in this district was followed in the development of other coke-making districts. Ironmasters became accustomed to the use of beehive coke and have shown a prejudice to retort-oven coke, principally because it does not possess the attractive silvery appearance of beehive coke. This prejudice probably more than anything else has been the most potential factor in retarding the development of the retort-oven industry in the United States.

The first by-product recovery ovens constructed in the United States were in an experimental plant of 12 Semet-Solvay ovens built at Syracuse, N. Y. That this branch of the industry has shown considerable development notwithstanding the prejudice against retort coke is shown by the fact that at the present time about 16 per cent of the total production of coke is obtained from by-product ovens. All of the coke produced in retort ovens is a fuel suitable for metallurgical purposes, but its use, like beehive coke, is not restricte tod the metallurgical industries. Where the retort ovens are located at iron or steel plants the coke may be considered the primary product and is used almost exclusively in the blast furnaces. Where the ovens are located in or near large cities, the coke becomes a secondary product, some of it being used in metallurgical operations and some in manufacturing, or by railroads, or for domestic consumption. The location of the plant rather than the quality of the coke determines whether the coke product is primary or secondary; but as it is impossible to make any accurate separation of the uses to which the coke is put, the entire production is included in the statistics, as compiled by the United States Geological Survey.

During the last two years a new type of longitudinal oven has been meeting with favor, particularly in the Lower Connellsville district of Pennsylvania. This is in reality a modification of the beehive oven, but constructed so that the coke may be pushed instead of drawn from the coking chamber. The process is one of partial combustion and not of distillation. At the close of 1909 there were 1,174 of these ovens, variously styled as Mitchell, rectangular, Belgian, and longitudinal, in operation and 746 in course of construction.

From the first plant of 12 by-product recovery ovens established by the Semet-Solvay Company at Syracuse in 1893, the number has increased until on December 31, 1909, there were 3,989 in operation and 949 in course of construction. In the report for 1908 it was stated that there were 4,007 by-product ovens in existence, but these included 208 Newton-Chambers ovens which have never been operated as by-product plants. The number of by-product recovery ovens at the end of 1908 was 3,799, so that there was an increase of 190 in in the number of this type of ovens during 1909. On December 31, 1909, there were 949 by-product ovens in course of construction, as compared with 240 under construction at the beginning of the year. This indicates an encouraging revival in the construction of by-product recovery plants. The details of the production of coke in retort ovens and of the quantity and value of by-products obtained are discussed more fully in the subsequent pages of this report.

The coal consumed in the manufacture of coke in the United States is drawn from the following bituminous regions or fields:

1. The Appalachian region, embracing the great coking coal fields of Pennsylvania, Virginia, West Virginia, Ohio, eastern Kentucky, Tennessee, Alabama, and Georgia.
2. The eastern interior region, which includes the coal fields of Illinois, Indiana, and western Kentucky.
3. The western interior region, embracing the States of Iowa, Kansas, Missouri, Nebraska, Oklahoma, and Arkansas.
4. The Rocky Mountain regions, contained within the States of Colorado, New Mexico, Utah, Montana, and Wyoming.
5. The Pacific coast regions, in which the only coking coals are found in the State of Washington.

The coal of the northern interior region lying wholly within the State of Michigan has not been used in the manufacture of coke. A considerable quantity of coke is made in States in which there are no coal fields—Massachusetts, Minnesota, New York, New Jersey, and Wisconsin. The ovens near Baltimore, Md., and at Delray and Wyandotte, Mich., are supplied with coal from other States. One of the two plants in Wisconsin is composed of beehive ovens in which coal drawn from the mines of Pennsylvania is used. This is the only beehive plant in operation outside of the coal-producing States. Some of the ovens in Ohio, Indiana, and Illinois, though in coal-mining States, draw their supply of coking coal from West Virginia. All of the other coking establishments outside of the States producing coking coal are retort-oven plants.

The unit of measurement used in this chapter is uniformly the short ton of 2,000 pounds.

PRODUCTION.

STATISTICS OF PRODUCTION IN 1909.

The combined production of beehive and retort oven coke in the United States in 1909 amounted to 39,315,065 short tons, valued at $89,965,483, against 26,033,518 tons, valued at $62,483,983 in 1908. The increase in 1909 over 1908 was 13,281,547 short tons, or 51.02 per cent in quantity, and $27,481,500, or 43.92 per cent in value. Notwithstanding this increase of over 50 per cent in the production of coke in 1909, the output was still 1,464,499 tons and $21,573,643 below the high record of 40,779,564 short tons, valued at $111,539,126, in 1907. In the chapter on the production of coal attention is called to its general decline in value throughout the United States, and the same is true of the product from the coke ovens. From the high record of $2.74 per ton made in 1907, the price declined to $2.40 in 1908 and to $2.29 in 1909. The decline of price in both coal and coke was due to the somewhat demoralized condition of the iron market during the first half of the year. Of the total production in 1909 of 39,315,065 short tons, 33,060,421 short tons, or 84.09 per cent, were produced in beehive ovens, and 6,254,644 short tons, or 15.91 per cent, was the output of by-product retort ovens. In 1908 the production of beehive coke was 21,832,292 short tons, and that of by-product coke was 4,201,226 tons. In one respect the year 1909 outclassed 1907 and exceeded all predecessors, and that was in the quantity of coke manufactured in by-product ovens. In 1907 the production of coke in retort ovens amounted to 5,607,899 short tons, and in 1909 the quantity of retort-oven coke made was 6,254,644 short tons. Compared with 1908 the production of beehive coke increased 11,228,129 tons, or 51.43 per cent, and that of retort coke increased 2,053,418 tons, or 48.88 per cent, the reason for the larger percentage of increase in beehive coke being that during the business depression of 1908 the output of beehive coke fell off to a much greater extent than that of retort oven coke.

In considering the total value and the average selling price for the coke produced in the United States it should be remembered that in many cases the coke ovens in this country are operated by large corporations which operate also coal mines and blast furnaces, the coke making being really only an incidental part of the business. In such cases the coke product is sometimes charged against the furnace deparment at cost and sometimes at a figure based upon the cost of coal mining and coke making, plus a percentage of profit on these operations. The value is not fixed by the market price. In other cases the value is estimated upon the average prices for coke of a similar quality produced and sold in the immediate vicinity. These conditions, however, continue from year to year and do not affect comparisons.

The quantity of coal consumed in the manufacture of coke in 1909 amounted to 59,354,937 short tons, valued at $62,203,382. The value of the coke produced from this coal was $89,965,483, the difference of $27,762,101 representing the profit on the coke making operations less cost of manufacture, expenses of administration, etc. In 1908 the value of the coal used was $45,222,474, and the value of the coke produced was $62,483,983, a difference of $17,261,509. In 1907 the difference between these two values was $38,754,275.

Although the quantity of coke made and consumed in the year 1909 indicated an improvement over 1908, the year 1909 can not be regarded as one of satisfaction to the producers. The production was brought up to within less than a million and a half tons of that of 1907, but the value in 1909 was more than $21,000,000 less than that of 1907. One of the reasons for the much lower value in 1909 was the deliveries of coke made at the low contract prices of 1908. The year opened with an effort to push the production with the result that prices were demoralized early in January. Prices improved somewhat later in the month because of a combination among what are known as the "coke independents" in the Connellsville district of Pennsylvania, meaning those not associated with the United States Steel Corporation; but the improvement was not of long duration, and in fact, prices were as low as they could go without stopping production altogether. In the latter part of February the United States Steel Corporation announced a reduction of prices on all finished iron and steel products with the exception of rails, and it was hoped that this would stimulate buying and help the coke situation, but as production was keeping ahead of demand, no improvement in prices was realized. By April stocks of coke had accumulated to such an extent that it was found impossible to maintain the agreement among the independent operators to hold prices for furnace coke. The situation in the coking regions appeared Micawber-like, for the operators were waiting for something better to turn up. An improved condition developed in the early part of June with increased production and sales, but without any material advance in prices. It was not until August that prices began to show any improvement, but once begun it continued for the rest of the year with production retarded only by the shortage of labor at the mines and ovens. During the latter half of the year prices for Connellsville coke ranged from $2.75 to $2.90 per ton for furnace coke, whereas in the early months of the year it was difficult to maintain the price at $1.75, even with the agreement among the independent operators. Much furnace coke sold as low as $1.60 per ton in the first six months of the year; at times during the last six months of the year it could not be had at $2.75.

The total number of coke ovens in the United States increased from 101,218 in 1908 to 103,982 in 1909, a gain of 2,764, of which increase 190 were by-product recovery ovens. Of the 103,982 ovens in existence in 1909, 8,501 were idle throughout the year. The number of idle ovens does not include those which were idle for a portion of the year, particularly the first half of the year. In 1908, of the 101,218 ovens, 12,920 were idle throughout the year. The number of ovens that were active—that is, were in blast for all or part of the year 1909—was 95,481, which produced 39,315,065 short tons of coke, an average of 411.8 tons per oven; in 1908 there were 88,298 ovens, which produced coke in that year, an average of 294.8 tons per oven. Of the 3,989 by-product recovery ovens in existence at the close of 1909, 50 had not been put in blast before the end of the year, and 25 were not operated; accordingly 3,914 retort ovens made coke in 1909, with an average of 1,598 tons of coke per oven.

At the close of 1909 there were 2,950 ovens in course of construction. Of the ovens building 949, or 32.17 per cent, were by-product recovery ovens. Of the 949 by-product ovens building, 40 at South Chicago were of the Semet-Solvay type, increasing the plant at that place to 200; 560 at Gary, Ind., were Koppers regenerative ovens; 49 at Cleveland, Ohio, were Semet-Solvay ovens, replacing part of the original Rothberg plant; and 300 Didier ovens in the Lehigh Valley of Pennsylvania were under contract by the Didier-March Company.

Considering each bank of ovens as a separate establishment, the returns for 1909 show a total of 579 establishments, against 551 in 1908 and 552 in 1907. Of these 579 establishments, 105, with a total of 8,501 ovens, were idle throughout the year, compared with 130 in 1908 and 67 in 1907. The 579 establishments included 3 with a total of 190 ovens which were completed but not put in blast before the end of the year.

The statistics of the production of coke in 1908 and 1909 are presented, by States and Territories, in the table following.

Manufacture of coke, by States and Territories, in 1908 and 1909.

1908.

State or Territory.	Establishments.	Ovens. Built.	Ovens. Building.	Coal used (short tons).	Yield of coal in coke (per cent).	Coke produced (short tons).	Total value of coke.	Price of coke per ton
Alabama	45	10,103	0	3,875,791	61.0	2,362,666	$7,169,901	$3.04
Colorado[a]	16	3,841	0	1,546,044	63.5	982,291	3,238,888	3.30
Georgia	2	350	0	71,452	55.2	39,422	137,524	3.72
Illinois	6	430	140	503,359	72.0	362,182	1,538,952	4.25
Kansas	6	67	0	3,790	65.9	2,497	8,011	3.21
Missouri	1	4	0	0	....	0	0	....
New Mexico	4	1,016	0	454,873	60.4	274,565	826,780	3.01
Ohio	7	481	50	237,448	67.2	159,578	491,982	3.08
Pennsylvania	252	52,606	1,720	23,215,964	66.8	15,511,634	32,569,621	2.10
Tennessee	17	2,792	20	395,936	54.2	214,528	561,789	2.62
Utah	2	864	0	(b)	....	(b)	(b)	....
Virginia	19	4,853	158	1,785,281	65.1	1,162,051	2,121,980	1.83
Washington	6	231	50	68,069	57.1	38,889	213,138	5.48
West Virginia	138	20,124	0	4,127,730	63.9	2,637,123	5,267,054	2.00
Indiana, Kentucky, Maryland, Massachusetts, Michigan, Minnesota, Montana, New Jersey, New York, Oklahoma, Wisconsin	30	3,456	103	3,155,100	72.5	2,286,092	8,338,363	3.65
Total	551	101,218	2,241	39,440,837	66.0	26,033,518	62,483,983	2.40

1909.

State or Territory.	Establishments.	Ovens. Built.	Ovens. Building.	Coal used (short tons).	Yield of coal in coke (per cent).	Coke produced (short tons).	Total value of coke.	Price of coke per ton
Alabama	43	10,061	0	5,080,764	60.7	3,085,824	$8,068,267	$2.61
Colorado[a]	16	3,846	0	1,984,985	63.1	1,251,805	4,135,931	3.30
Georgia	2	350	0	86,290	53.8	46,385	159,334	3.44
Illinois	5	468	40	1,682,122	75.9	1,276,956	5,361,510	4.20
Kansas	6	67	0	0	....	0	0	....
Kentucky	6	494	0	89,083	52.0	46,371	101,257	2.18
Missouri	1	4	0	0	....	0	0	....
New Mexico	4	1,030	0	694,390	53.9	373,967	1,099,694	2.94
Ohio	7	447	49	340,735	65.4	222,711	683,155	3.07
Oklahoma	5	536	0	0	....	0	0	....
Pennsylvania	283	54,506	2,072	36,983,568	67.3	24,905,525	50,377,035	2.02
Tennessee	16	2,729	0	493,283	53.1	261,808	667,723	2.55
Utah	2	854	0	(b)	....	(b)	(b)	....
Virginia	19	5,469	100	2,060,518	65.4	1,347,478	2,415,769	1.79
Washington	6	285	0	69,708	61.7	42,981	240,604	5.60
West Virginia	138	20,283	126	6,361,759	62.0	3,943,948	7,525,922	1.99
Indiana, Maryland, Massachusetts, Michigan, Minnesota, Montana, New Jersey, New York, Wisconsin	20	2,553	563	3,427,732	73.3	2,509,306	9,129,282	3.64
Total	579	103,982	2,950	59,354,937	66.2	39,315,065	89,965,483	2.29

a Includes the production of Utah.

b Production included with Colorado.

PRODUCTION IN PREVIOUS YEARS.

In his interesting work, "A treatise on coke," Mr. John Fulton states that in 1835 the Franklin Institute of Pennsylvania offered a premium of a gold medal to "the person who will manufacture in the United States the greatest quantity of iron from the ore during the year, using no other fuel but bituminous coal or coke, the quantity to be not less than 20 tons." In the same year, according to Mr. Fulton, Mr. William Fernstone made some good quality gray forge iron at the Mary Ann furnace in Huntingdon County, Pa., with coke made from Broad Top coal. Mr. James M. Swank, general manager of the American Iron and Steel Association, has suggested that the early efforts in the use of coke for iron making were made in mixtures with charcoal. Mr. Fulton also states that in 1837 F. H. Oliphant made 100 tons of iron, using coke as fuel, at the Fairchance furnace, near Uniontown, in Fayette County, Pa., and that in the same year coke was used at the Lonaconing furnace at Frostburg, Md. It is probable that the coke used in these furnaces was made in pits, as it is not known that there was any coke made in ovens prior to 1841, when two carpenters named Province McCormick and James Campbell and a stone mason named John Taylor built two ovens in the Connellsville region. They got little reward for their pains. The output of coke, amounting to possibly 1,500 bushels, was taken to Cincinnati, but had to be sold at a loss, and this enterprise was abandoned. The census of 1850 (Seventh United States Census) reported that there were 4 coke-making establishments in the United States in that year, but did not mention either the number of ovens or the quantity and value of the coke produced. The Eighth Census of 1860 reported 21 coke-making establishments and at the taking of the Ninth Census in 1870 there were 25 establishments engaged in this industry, but in neither year was the quantity or value of the coke reported nor did these reports state the number of ovens in use. The only records of these former years in regard to the quantity of coke manufactured and used were the reports of the American Iron and Steel Association, which contain statements of the quantity of pig iron made with coke, but do not report the total quantity of coke made. According to this authority most of the iron produced in the United States prior to 1855 was made with charcoal as fuel. In 1855 the use of anthracite exceeded that of charcoal, and anthracite maintained this supremacy in iron making until 1875, when it was superseded by coke. Since 1875 the percentage of anthracite iron made in the United States has gradually decreased and is now not a factor of any importance in the industry. The first record of the quantity of coke produced in the United States is contained in the census report for 1880. In that year the production amounted to 3,338,300 short tons. Since 1880 the statistics have been compiled annually by the United States Geological Survey and published in the corresponding volume of Mineral Resources of the United States. The manufacture of coke has kept pace with the progress of other industries, particularly with iron and steel manufacture and railroad construction. At the taking of the Eleventh Census in 1889 the production of coke was little more than three times that of the quantity reported in 1880, and amounted to 10,258,022 short tons. By 1899 it had again almost doubled, the production in that year being 19,668,569 short tons. In 1909 the production was again almost double, 39,315,065 tons. During this period of thirty years there have been eight years of decreased production as compared with the year immediately preceding, the most pronounced instances being in the panic years of 1893 and 1894 and in the recent business depression of 1908.

In the following table is presented a statement of the quantity of coke produced in the United States in each year since 1880:

Quantity of coke produced in the United States, 1880–1909, in short tons.

1880	3,338,300	1890	11,508,021	1900	20,533,348
1881	4,113,760	1891	10,352,688	1901	21,795,883
1882	4,793,321	1892	12,010,829	1902	25,401,730
1883	5,464,721	1893	9,477,580	1903	25,274,281
1884	4,873,805	1894	9,203,632	1904	23,661,106
1885	5,106,696	1895	13,333,714	1905	32,231,129
1886	6,845,369	1896	11,788,773	1906	36,401,217
1887	7,611,705	1897	13,288,984	1907	40,779,564
1888	8,540,030	1898	16,047,209	1908	26,033,518
1889	10,258,022	1899	19,668,569	1909	39,315,065

In the following table is presented a statement of the production of coke in each State from 1905 to 1909, inclusive, with the increases in the 1909 production as compared with that of 1908. Among the States and Territories for which the statistics are published separately there was not one in which the production decreased as compared with the preceding year. This was in marked contrast to the statistics presented in 1908, when with only one exception—New Mexico—the production decreased in every State. The percentage of increase in 1909 ranged from 10.52 in Washington to 252.57 in Illinois, the great increase in the latter State being due to the operation of the Koppers ovens of the United States Steel Corporation at Joliet, one-half of which establishment was operated during 1908. The production of Illinois increased from 362,182 short tons in 1908 to 1,276,956 short tons in 1909. This coke, however, is made from coal drawn from the mines of West Virginia and not of Illinois, and might properly be credited to West Virginia. In tonnage the most important increase was made in the Connellsville and Lower Connellsville districts of Pennsylvania, the total production for the State showing an increase in 1909 over 1908 of 9,393,891 tons, or 60.56 per cent. The production of West Virginia increased 1,306,825 short tons, or 49.55 per cent, and that of Alabama 723,158 tons, or 30.61 per cent. It will be noted in the following tables, however, that with the exception of the combined production of Colorado and Utah and of that of Washington, the percentage of increase in value was less than the percentage of increase in production.

Quantity of coke produced in the United States, 1905-1909, by States and Territories, in short tons, with increase and decrease in 1909.

State or Territory	1905.	1906.	1907.	1908.	1909.	Increase (+) or decrease (−) in quantity of coke produced, 1908-9.	Percentage of increase (+) or decrease (−) in quantity of coke produced.
Alabama	2,576,986	3,034,501	3,021,794	2,362,666	3,085,824	+ 723,158	+ 30.61
Colorado [a]	1,378,824	1,455,905	1,421,579	982,291	1,251,805	+ 269,514	+ 27.44
Georgia	70,593	70,280	74,934	39,422	46,385	+ 6,963	+ 17.66
Illinois	10,307	268,693	372,697	362,182	1,276,956	+ 914,774	+252.57
Kansas	4,425	1,698	6,274	2,497	....	(b)	(b)
Kentucky	79,487	74,064	(b)	(b)	46,371	(b)	(b)
Missouri	1,580	....	....	....	....	....	....
Montana	31,482	38,182	(b)	(b)	(b)	(b)	(b)
New Mexico	89,638	147,747	265,125	274,565	373,967	+ 99,402	+ 36.20
Ohio	277,130	293,994	270,634	159,578	222,711	+ 63,133	+ 39.56
Oklahoma (Indian Territory)	54,781	49,782	(b)	(b)	....	....	....
Pennsylvania	20,573,736	23,060,511	26,513,214	15,511,634	24,905,525	+ 9,393,891	+ 60.56
Tennessee	468,092	483,428	467,499	214,528	261,808	+ 47,280	+ 22.04
Utah	(c)	(c)	(c)	(c)	(c)	(c)	(c)
Virginia	1,499,481	1,577,659	1,545,280	1,162,051	1,347,478	+ 185,427	+ 15.96
Washington	53,137	45,642	52,028	38,889	42,981	+ 4,092	+ 10.52
West Virginia	3,400,593	3,713,514	4,112,896	2,637,123	3,943,948	+ 1,306,825	+ 49.55
Other States	1,660,857	2,085,617	2,655,610	2,286,092	2,509,306	+ 267,088	+ 11.67
Total	32,231,129	36,401,217	40,779,564	26,033,518	39,315,065	+13,281,547	+ 51.02

[a] Colorado includes Utah.
[b] Included with other States having less than three producers.
[c] Included with Colorado.

In the following table is given a statement of the establishments, the number of ovens built and building, the quantity of coal used, the quantity of coke produced, the value of the coke, the average price per ton, and the percentage yield of coal in coke for the years 1880, 1890, 1900, and from 1901 to 1909, inclusive:

Statistics of the manufacture of coke in the United States in 1880, 1890, and 1900-1909.

Year.	Establishments.	Ovens.		Coal used (short tons).	Coke produced (short tons).	Total value of coke at ovens.	Value of coke at ovens, per ton.	Percentage yield of coal in coke.
		Built.	Building.					
1880	186	12,372	1,159	5,237,741	3,338,300	$6,631,267	$1.99	63.0
1890	253	37,158	1,547	18,005,209	11,508,021	23,215,302	2.02	64.0
1900	396	58,484	5,804	32,113,553	20,533,348	47,443,331	2.31	63.9
1901	423	63,951	5,205	34,207,965	21,795,883	44,445,923	2.04	63.7
1902	456	69,069	8,758	39,604,007	25,401,730	63,339,167	2.49	64.1
1903	500	79,334	6,175	39,423,525	25,274,281	66,498,664	2.63	64.1
1904	507	83,599	4,430	36,531,608	23,661,106	46,144,941	1.95	64.8
1905	519	87,564	4,751	49,530,677	32,231,129	72,476,196	2.25	65.1
1906	532	93,901	4,519	55,746,374	36,401,217	91,608,034	2.52	65.3
1907	552	99,680	2,546	61,946,109	40,779,564	111,539,126	2.74	65.8
1908	551	101,218	2,241	39,440,837	26,033,518	62,483,983	2.40	66.0
1909	579	103,982	2,950	59,354,937	39,315,065	89,965,483	2.29	66.2

VALUE OF COKE PRODUCED.

Following a year of such marked business depression as 1908, it would naturally be supposed that the value of the coke in 1909 would increase in greater proportion than the production. It must be remembered, however, that a large part of the coke made and sold in 1909 was upon contracts made at the low prices of 1908. Moreover, there was no marked increase in the demand for coke during the first six months of the year, and production was so greatly in excess of requirement that spot prices in some places were depressed even below those obtaining in 1908. After the 1st of July demand improved and, on account of the shortage of labor in the mining and coking regions, got ahead of production, so that prices rose accordingly, but the value of the spot coke sold during the last six months of the year was not sufficient to overcome the effect of the low prices of the first six months. The total value of the coke produced in the United States in 1909 was $89,965,483, an increase of $27,481,500, or 43.92 per cent over 1908. The value of the product in 1909 was more than $21,000,000 less than in 1907, when the production exceeded that of 1909 by 1,464,499 tons. In the following tables are presented statements showing the value of coke produced in the several States and Territories for the last five years with the amount and percentage of increase in 1909 as compared with 1908 and the total value of the coke produced in the United States in each year since 1880:

Total value, at the ovens, of the coke made in the United States, 1905–1909, by States and Territories, with increase and decrease in 1909.

State or Territory.	1905.	1906.	1907.	1908.	1909.	Increase (+) or decrease (−) in value of coke produced. 1908–9.	Percentage of increase (+) or decrease (−) in value of coke produced.
Alabama	$7,646,957	$8,477,899	$9,216,194	$7,169,901	$8,068,267	+ $898,366	+ 12.53
Colorado [a]	4,157,517	4,504,748	4,747,436	3,238,888	4,135,931	+ 897,043	+ 27.70
Georgia	224,260	277,921	315,371	137,524	159,334	+ 21,810	+ 15.86
Illinois	27,681	1,205,462	1,737,464	1,538,952	5,361,510	+ 3,822,558	+248.39
Kansas	13,818	4,101	19,837	8,011	....	(b)	(b)
Kentucky	159,659	169,846	(b)	(b)	101,257	(b)	(b)
Missouri	4,072	....	....	....	....	....	....
Montana	211,351	266,024	(b)	(b)	(b)	(b)	(b)
New Mexico	253,229	442,712	840,253	826,780	1,099,694	+ 272,914	+ 33.01
Ohio	970,897	1,013,248	819,262	491,982	683,155	+ 191,173	+ 38.86
Oklahoma (Indian Territory)	199,424	204,205	(b)	(b)	....	....	....
Pennsylvania	42,253,178	54,184,531	67,638,024	32,569,621	50,377,035	+17,807,414	+ 54.67
Tennessee	1,184,442	1,350,856	1,592,225	561,789	667,723	+ 105,934	+ 18.86
Utah	(c)	(c)	(c)	(c)	(c)	(c)	(c)
Virginia	2,869,452	3,611,659	3,765,733	2,121,980	2,415,769	+ 293,789	+ 13.85
Washington	251,717	226,977	293,019	213,138	240,604	+ 27,466	+ 12.89
West Virginia	6,548,205	8,192,956	9,717,130	5,267,054	7,525,922	+ 2,258,868	+ 42.89
Other States	5,500,337	7,474,889	10,837,178	8,338,363	9,129,282	+ 884,165	+ 10.59
Total	72,476,196	91,608,034	111,539,126	62,483,983	89,965,483	+27,481,500	+ 43.92

[a] Includes value of Utah coke.
[b] Included in other States having less than three producers.
[c] Included with Colorado.

Total value, at the ovens, of the coke made in the United States, 1880-1909.

1880	$6,631,265	1890	$23,215,302	1900	$47,443,331
1881	7,725,175	1891	20,393,216	1901	44,445,923
1882	8,462,167	1892	23,536,141	1902	63,339,167
1883	8,121,607	1893	16,523,714	1903	66,498,664
1884	7,242,878	1894	12,328,856	1904	46,144,941
1885	7,629,118	1895	19,234,319	1905	72,476,196
1886	11,153,366	1896	21,660,729	1906	91,608,034
1887	15,321,116	1897	22,102,514	1907	111,539,126
1888	12,445,963	1898	25,586,699	1908	62,483,983
1889	16,630,301	1899	34,670,417	1909	89,965,483

From the preceding statements, showing the quantity and value of the coke produced in a series of years, the following tables have been prepared. These show the average price per ton obtained for the coke product in each State and Territory for the last five years and the average price of the total product since 1880. These average prices are obtained by dividing the total value by the total quantity of coke produced or sold. Although the figures may be accepted as indicating the general tendency of prices, they do not always represent the actual selling value of the coke, as has already been explained. Some of the largest producers of coke consume their entire product in their own blast furnaces. By some such producers the value of the coke is given at the actual cost of production; by others it is based upon the cost of production, a percentage of profit on the coking operations being added; and by still others the values are based upon the marketed product of a similar quality of coke in the immediate vicinity. These conditions, however, continue without material change from year to year, so that the prices as given may be accepted as indicating the general condition of the market.

As will be seen from the following tables, the average price per ton in 1907 was the highest recorded in the thirty years covered by this series of reports. Prior to 1907 the highest average price recorded was in 1903, when, because of the fuel famine produced by a strike in the anthracite region of Pennsylvania, the demand for coke was abnormally large and prices were correspondingly stimulated. A depression in the iron trade in 1904 added to local competition for trade in the coking regions created a violent reaction, and prices were lower in that year than in any year of the present century. When the conditions that existed in 1908 are considered, the decline in price was less than might have been expected. The reason for this was that a large quantity of the coke sold in 1908 was on the contract prices of 1907. Similarly, in 1909 a large quantity of the coke delivered was at contract prices made in 1908, and although there was a marked recovery in the latter half of 1909 with demand in excess of production, the comparatively small quantity of spot coke which was sold at the advanced prices was not sufficient to overcome the effect of the much larger quantity of coke sold at the low contract prices of 1908 and of the first six months of 1909.

The average prices of coke, by States, from 1905 to 1909, inclusive, and for the United States from 1880 to 1909 are shown in the tables following.

Average price per short ton, at the ovens, of the coke made in the United States, 1905–1909, by States and Territories.

State or Territory.	1905.	1906.	1907.	1908.	1909.
Alabama	$2.97	$2.79	$3.05	$3.04	$2.61
Colorado [a]	3.02	3.09	3.34	3.30	3.30
Georgia	3.18	3.95	4.21	3.72	3.44
Illinois	2.69	4.48	4.66	4.25	4.20
Kansas	3.12	2.42	3.16	3.21	....
Kentucky	2.01	2.29	2.35	(b)	2.18
Missouri	2.58	....	....	....	....
Montana	6.71	6.97	7.25	(b)	(b)
New Mexico	2.83	3.00	3.17	3.01	2.94
Ohio	3.50	3.45	3.03	3.08	3.07
Oklahoma (Indian Territory)	3.64	4.10	4.32	(b)	....
Pennsylvania	2.05	2.35	2.55	2.10	2.02
Tennessee	2.53	2.79	3.41	2.62	2.55
Utah	(c)	(c)	(c)	(c)	(c)
Virginia	1.91	2.29	2.44	1.83	1.79
Washington	4.74	4.97	5.63	5.48	5.60
West Virginia	1.92	2.21	2.36	2.00	1.99
Other States	3.31	3.58	4.07	3.65	3.64
Average	2.25	2.52	2.74	2.40	2.29

[a] Includes Utah.
[b] Included in other States having less than three producers.
[c] Included with Colorado.

Average price per short ton, at the ovens, of the coke made in the United States, 1880–1909.

1880	$1.99	1890	$2.02	1900	$2.31
1881	1.88	1891	1.97	1901	2.04
1882	1.77	1892	1.96	1902	2.49
1883	1.49	1893	1.74	1903	2.63
1884	1.49	1894	1.34	1904	1.95
1885	1.49	1895	1.44	1905	2.25
1886	1.63	1896	1.84	1906	2.52
1887	2.01	1897	1.66	1907	2.74
1888	1.46	1898	1.59	1908	2.40
1889	1.62	1899	1.76	1909	2.29

NUMBER OF COKE WORKS AND OVENS IN THE UNITED STATES.

Each bank of ovens being considered as a separate establishment, there were 579 establishments manufacturing coke in the United States at the close of 1909, an increase of 28 as compared with 1908. These 579 establishments included 3 with a total of 190 ovens which were completed but not put in blast before the end of the year, and which, consequently, did not contribute to the production. The ovens of these 3 establishments are included among the idle ovens; the ovens which were not completed are not considered as idle. In 1908 there were 7 establishments, with a total of 370 ovens, which had been completed, but which were not put in blast during that year. In addition to the 3 establishments which were completed but not put in blast in 1909 there were 102 other establishments, with a total of 8,311 ovens, which were idle throughout the year. The idle plants averaged about 90 ovens each. There were 2 establishments with a total of 152 ovens reported as permanently abandoned, one of which, however, contributed to the production in 1909. There were also 49 ovens belonging to other establishments reported as abandoned. The idle plants and those not completed before the end of the year being deducted, a total of 105 establishments, there appear to have been 474 active establishments, comprising 95,481 ovens, or an average of 201 ovens to each plant.

The 474 active establishments in 1909 produced 39,315,065 short tons of coke, an average of 82,943 tons for each plant. In 1908 there were 421 active establishments, which produced 26,033,518 short tons of coke, an average of 61,837 tons for each plant. In 1907 there were 485 active establishments, which produced 40,779,564 tons of coke, an average of 84,082 tons per plant. The average output for each plant in 1909 was 34.13 per cent greater than in 1908 and only 1.36 per cent less than in 1907. In 1880, the first year for which these statistics were collected, there were 186 establishments, with an average production from each of 17,948 tons, indicating that the average output from each plant in 1909 was about four and a half times that of 1880.

It should be stated that the word "establishment" as used in this report is intended to designate the number of separate plants or banks of ovens, whether operated or idle, and whether reported from one central office or not. Different plants controlled or operated by one company are considered separate establishments.

The total number of establishments manufacturing coke in the United States at the end of each decade from 1850 to 1900 and at the end of each year from 1901 to 1909, inclusive, is shown in the following table. The numbers reported in 1850, 1860, and 1870 are for census years; the others are for calendar years.

Number of coke establishments in the United States since 1850.

1850 (census year)	4	1900, December 31	396	1905, December 31	519
1860 (census year)	21	1901, December 31	423	1906, December 31	532
1870 (census year)	25	1902, December 31	456	1907, December 31	552
1880, December 31	186	1903, December 31	500	1908, December 31	551
1890, December 31	253	1904, December 31	506	1909, December 31	579

The following table shows the number of coke ovens in existence in each State and Territory on December 31 for each of the last five years, and at the end of each five years since 1880. The total number of ovens in existence at the close of 1909 (103,982) was 19 per cent more than in 1905, more than double the number in existence in 1895, and nearly nine times the number in existence in 1880.

Number of coke ovens in each State or Territory at the close of each year, 1905–1909.

State or Territory.	1905.	1906.	1907.	1908.	1909.
Alabama	9,586	9,731	9,889	10,103	10,061
Colorado	3,421	3,419	3,799	3,841	3,846
Georgia	533	531	350	350	350
Illinois	275	309	309	430	468
Indiana	36	48	28	46	96
Kansas	91	81	83	67	67
Kentucky	495	462	495	495	494
Maryland	200	200	200	200	200
Massachusetts	400	400	400	400	400
Michigan	135	150	150	150	162
Minnesota	50	50	50	50	50
Missouri	6	6	5	4	4
Montana	555	555	567	551	551
New Jersey	100	150	150	150	150
New Mexico	258	571	896	1,016	1,030
New York	399	540	540	540	556
Ohio	573	575	600	481	447
Oklahoma (Indian Territory)	388	490	490	486	536
Pennsylvania	42,608	47,185	51,364	52,606	54,506
Tennessee	2,615	2,731	2,806	2,792	2,729
Utah	504	684	884	864	854
Virginia	4,549	4,641	5,333	4,853	5,469
Washington	216	216	216	231	285
West Virginia	19,189	19,714	19,688	20,124	20,283
Wisconsin	308	388	388	388	388
Wyoming	74	74	0	0	0
Total	87,564	93,901	99,680	101,218	103,982

Number of coke ovens in the United States on December 31 of each fifth year, from 1880 to 1909.

1880	12,372	1900	58,484
1885	20,116	1905	87,564
1890	37,158	1909	103,982
1895	45,565		

A statement of the number of ovens in course of construction at the end of each year since 1905 is shown in the following table. It is not intended to show by this table the increase in the number of new ovens from year to year, nor does it include the number of new ovens completed during any one year. It merely exhibits the condition of the industry as shown by plants under construction at the close of each year.

Number of coke ovens building in the United States at the close of each year, 1905–1909.

1905	4,751	1908	2,241
1906	4,519	1909	2,950
1907	2,546		

RANK OF COKE-PRODUCING STATES.

In the manufacture of coke, as in the production of coal and in the manufacture of iron and steel, Pennsylvania far outranks the other States of the Union, and for the entire period covered by the annual reports, Mineral Resources of the United States, has contributed more than 50 per cent of the total quantity of coke produced in the United States. West Virginia and Alabama have during the same period been close rivals for second place among the coke-producing States, frequently alternating from one year to another, although during the last five years West Virginia has held the place of honor, with Alabama ranking third. In 1909 West Virginia's production was 900,000 tons, or nearly 30 per cent more than that of Alabama, but in value of coke produced Alabama had the better of West Virginia by over $500,000. In this, as in the production of coal, Alabama exhibits the advantage of the possession of local markets for its product. The average quality of West Virginia coke is undoubtedly superior to that of the coke produced in Alabama, and yet because of the local furnaces to consume the output the price of Alabama coke in 1909 was considerably higher than that of West Virginia, and notwithstanding the much larger tonnage produced in West Virginia the value of Alabama coke was greater. The operation of the Koppers plant of ovens at Joliet, Ill., brought that State from ninth to fifth place as a coke producer, Colorado being reduced to sixth. The production of coke in Illinois was within 6 per cent of that of Virginia, which continues in fourth place. The indications are that Illinois will supplant Virginia for 1910.

The relative rank of the coke-producing States and Territories during the last five years is shown in the table following.

Rank of the States and Territories in production of coke, 1905-1909.

State or Territory.	1905.	1906.	1907.	1908.	1909.
Pennsylvania	1	1	1	1	1
West Virginia	2	2	2	2	2
Alabama	3	3	3	3	3
Virginia	4	4	4	4	4
Illinois	22	14	10	9	5
Colorado	5	5	5	5	6
New York	14	8	6	6	7
Wisconsin	12	13	7	8	8
Massachusetts	7	7	9	7	9
New Mexico	15	16	15	10	10
Michigan	9	11	13	13	11
Maryland	8	9	11	11	12
Tennessee	6	6	8	14	13
New Jersey	13	15	16	12	14
Ohio	10	12	14	15	15
Utah	11	10	12	16	16
Minnesota	16	17	17	17	17
Georgia	18	19	18	18	18
Kentucky	17	18	19	20	19
Washington	20	21	20	19	20
Montana	21	22	21	21	21
Indiana	....	....	....	24	22
Oklahoma	19	20	22	22	....
Kansas	23	23	23	23	....
Wyoming	24	24	....	....	....
Missouri	25	....	....	....	....

COAL CONSUMED IN THE MANUFACTURE OF COKE.

As has been stated in previous reports of this series, the determination of the quantity of coal consumed in the manufacture of coke is, to a considerable extent, a matter of estimate, as a large quantity of the coal so used is charged directly into the ovens from the mines without having been previously weighed or measured. The only method of ascertaining the quantity of coal thus used is by the amount paid to the miners for mining, which is based sometimes on the measured bushel or ton and sometimes on the cubical contents of the mine car. All these standards are likely to differ materially from that of the weighed ton or bushel. There are comparatively few establishments in this country at which the quantity of coal made into coke is accurately ascertained, though as the industry becomes better organized greater attention is paid to exactness in this regard, and year by year the quantities as presented in the following tables become more accurate. It is still necessary, however, to estimate a large quantity of the coal consumed in the manufacture of coke.

A considerable quantity of the coal which is not run directly from the mines to the coke ovens is crushed and washed before coking. At some of the establishments the weight of this coal before washing is given approximately; at others the weight, after the slate, pyrite, and other impurities have been removed, is reported for the weight of the coal charged into the ovens; at still others coke ovens have been constructed chiefly for the purpose of utilizing the slack coal produced, in which case little or no account is taken of the weight of the coal. It can readily be seen, therefore, that any statement as to the quantity of coal used in the manufacture of coke is necessarily approximate; but as these differences appear from year to year the statistics as collected may be accepted as sufficiently accurate for comparative analysis. As has been stated, an apparent discrepancy appears between the statements regarding the quantities of coal consumed in the manufacture of coke as published in the chapter on coal production and those presented herewith. These discrepancies are, in general, due to the fact that a large quantity of coal is shipped to ovens at a distance from the mine. Where this is the case, the tonnage so shipped would be included in the shipments, the coal statistics showing only the quantity of coal made into coke at the mines.

The total quantity of coal made into coke in 1909 was 59,354,937 short tons, compared with 39,440,837 used in 1908, a gain of 19,914,100 short tons, or 50.49 per cent.

In the chapter on the production of coal the statistics show that the quantity of coal made into coke in 1909 at the mines was 48,677,611 tons, the difference of 10,677,326 tons being the coal which was included in the shipments and sent to points distant from the mines before being charged into the coke ovens.

The quantity of coal used in the manufacture of coke, as obtained for this report from the several States and Territories, from 1905 to 1909, and the quantity used during each fifth year since 1880, are shown in the following tables:

Quantity of coal used in the manufacture of coke in the United States, 1905–1909, by States and Territories, in short tons.

State or Territory.	1905.	1906.	1907.	1908.	1909.
Alabama	4,409,854	5,184,597	4,973,296	3,875,791	5,080,764
Colorado [a]	2,368,365	2,566,196	2,388,911	1,546,044	1,984,985
Georgia	119,036	128,052	136,031	71,452	86,290
Illinois	16,821	362,163	514,983	503,359	1,682,122
Kansas	6,504	2,807	11,392	3,790	0
Kentucky	154,783	148,448	129,538	(b)	89,083
Missouri	2,551	0	0	0	0
Montana	68,777	69,045	68,948	(b)	(b)
New Mexico	148,469	261,609	446,140	454,873	694,390
Ohio	396,961	437,567	376,759	237,448	340,735
Oklahoma (Indian Territory)	123,389	95,296	38,615	(b)	0
Pennsylvania	31,030,345	34,503,513	39,733,177	23,215,964	36,983,568
Tennessee	862,320	929,405	825,221	395,936	493,283
Utah	(c)	(c)	(c)	(c)	(c)
Virginia	2,184,369	2,296,227	2,264,720	1,785,281	2,060,518
Washington	85,715	76,896	85,860	68,069	69,708
West Virginia	5,329,695	5,822,619	6,536,795	4,127,730	6,361,759
Other States	2,222,723	2,861,934	3,415,723	3,155,100	3,427,732
Total	49,530,677	55,746,374	61,946,109	39,440,837	59,354,937

[a] Includes coal coked in Utah.
[b] Included in other States having less than three producers.
[c] Included with Colorado.

Quantity of coal used in the manufacture of coke in the United States each fifth year, 1880–1909.

Year	Short tons.	Year	Short tons.
1880	5,237,741	1900	32,113,543
1885	8,071,126	1905	49,530,677
1890	18,005,209	1909	59,354,937
1895	20,848,323		

QUANTITY AND VALUE OF COAL USED IN COKE MAKING.

The total quantity and value of the coal consumed in the manufacture of coke in 1908 and 1909, with the quantity and value of the coal consumed per ton of coke produced, by States and Territories, are shown in the following table:

Quantity and value of coal used in the manufacture of coke in the United States in 1908 and 1909, and quantity and value of same per ton of coke, by States and Territories.

1908.

State or Territory.	Coal used (short tons).	Total value of coal.	Value of coal per ton.	Quantity of coal per ton of coke (short tons).	Value of coal to a ton of coke.
Alabama	3,875,791	$4,917,350	$1.27	1.640	$2.083
Colorado [a]	1,546,044	1,606,951	1.04	1.574	1.637
Georgia	71,452	91,260	1.28	1.813	2.321
Illinois	503,359	1,316,065	2.61	1.390	3.628
Kansas	3,790	5,222	1.38	1.518	2.095
New Mexico	454,873	519,115	1.14	1.657	1.889
Ohio	237,448	434,134	1.83	1.488	2.723
Pennsylvania	23,215,964	23,250,885	1.001	1.497	1.498
Tennessee	395,936	491,089	1.24	1.846	2.289
Virginia	1,785,281	1,506,447	.84	1.536	1.290
Washington	68,069	167,571	2.46	1.750	4.305
West Virginia	4,127,730	3,560,342	.86	1.565	1.346
Other States [b]	3,155,190	7,358,993	2.33	1.380	3.215
Total	39,440,837	45,222,474	1.15	1.515	1.742

1909.

State or Territory.	Coal used (short tons).	Total value of coal.	Value of coal per ton.	Quantity of coal per ton of coke (short tons).	Value of coal to a ton of coke.
Alabama	5,080,744	$6,167,268	$1.21	1.646	$1.992
Colorado [a]	1,984,985	2,467,403	1.24	1.586	1.967
Georgia	86,290	104,399	1.22	1.860	2.269
Illinois	1,682,122	4,812,850	2.86	1.317	3.767
Kentucky	89,083	72,983	.82	1.921	1.575
New Mexico	694,390	650,876	.94	1.857	1.746
Ohio	340,735	619,221	1.82	1.530	2.785
Pennsylvania	36,983,568	32,065,729	.87	1.485	1.292
Tennessee	493,283	514,501	1.04	1.884	1.959
Virginia	2,060,518	1,737,910	.84	1.529	1.284
Washington	69,708	153,519	2.20	1.622	3.568
West Virginia	6,361,759	4,878,027	.77	1.613	1.242
Other States [c]	3,427,732	7,958,136	2.32	1.366	3.169
Total	59,354,937	62,203,382	1.05	1.510	1.536

[a] Includes Utah.
[b] Includes Indiana, Kentucky, Maryland, Massachusetts, Michigan, Minnesota, Montana, New Jersey New York, Oklahoma, and Wisconsin.
[c] Includes Indiana, Maryland, Massachusetts, Michigan, Minnesota, Montana, New Jersey New York and Wisconsin.

The quantity of coal consumed in the manufacture of coke in 1909 increased from 39,440,837 short tons to 59,354,937 in 1909, while the value increased from $45,222,474 to $62,203,382. The increase in the value of the coal used was considerably less in proportion than the increase in the value of the coke produced. The difference in value of the coal used in 1909 and 1908 was $16,980,908, or 37.55 per cent. The average value per ton for the coal decreased from $1.15 in 1908 to $1.05 in 1909, but in considering these values it must be remembered that, as previously explained, the fixing of them is purely an arbitrary matter and they can not be said to represent actual market conditions. The total value of the coke increased

$27,481,500, or 43.92 per cent, from 1908 to 1909, while the average selling price per ton of coke declined from $2.40 in 1908 to $2.29 in 1909.

The following table shows approximately the quantity of coal, expressed in tons and pounds, required to produce a ton of coke in 1880, 1890, 1900, and annually since 1901. It will be noted that up to 1903 the quantity of coal required to produce a short ton of coke was from 3,120 to 3,140 pounds, or 1.56 to 1.57 tons. Since 1903 there has been a steady decrease in the quantity of coal required to produce a ton of coke, the lowest figure, 3,020 pounds, being reported in 1909. This improvement has been due entirely to the increased production of coke in retort ovens, this output having increased from 1,882,394 tons in 1903 to 6,254,644 in 1909.

Coal required to produce a ton of coke, in tons and pounds.

Year.	Tons.	Pounds.	Year.	Tons.	Pounds.
1880	1.57	3,140	1904	1.544	3,088
1890	1.56	3,120	1905	1.537	3,074
1900	1.57	3,140	1906	1.531	3,062
1901	1.57	3,140	1907	1.519	3,038
1902	1.56	3,120	1908	1.515	3,030
1903	1.56	3,120	1909	1.510	3,020

YIELD OF COAL IN COKE.

The influence of the increased production of coke from by-product ovens is exhibited by the gradual increase in the percentage yield of coal in coke, and as the beehive oven is superseded, as it must be eventually, by the retort oven, this practical conservation of resources will continue to grow. In 1880, before any retort-oven coke was made in the United States, the percentage yield of coal in coke was 63; in 1909 it was 66.2. In retort-oven practice the quantity of coal consumed in the ovens is usually accurately determined and amounted in 1909 to 8,390,129 short tons, yielding 6,254,644 tons of coke, an average yield of coal in coke of 74.5 per cent. After deducting the quantity of coal charged into retort ovens from the total quantity of coal used in the manufacture of coke, it is found that in 1909 there were 50,964,808 tons of coal used in the beehive or partial-combustion oven, which yielded 33,060,421 short tons of coke, or 64.9 per cent of the coal was converted into coke.

As stated in the discussion of the quantity of coal made into coke it is not always possible to obtain exact information concerning the actual quantity of coal consumed, as the coal charged into the ovens is not always weighed before coking, and therefore the quantity charged into the ovens is largely an estimate based sometimes upon the measured bushel or car, sometimes upon the cubical contents of the "larry," and sometimes upon the amount paid to the miner for his labor. There has been, however, a gratifying tendency on the part of producers to employ more exact methods in coke-oven operations, and also in the keeping of records. For this reason these figures have shown greater accuracy from year to year. It is entirely probable that the percentage yield as reported for earlier years was in excess of that actually obtained.

The following tables show the percentage yield of coal in coke in each State and Territory during the last five years, and for the United States in each tenth year since 1880 and annually since 1901:

Percentage yield of coal in coke, 1905–1909, by States and Territories.

State or Territory.	1905.	1906.	1907.	1908.	1909.
Alabama	58.4	58.5	61.0	61.0	60.7
Colorado [a]	58.2	56.7	59.5	63.5	63.1
Georgia	59.3	54.9	55.1	55.2	53.8
Illinois	61.3	74.2	72.3	72.0	75.9
Indiana	....	....	....	70.0	44.4
Kansas	68.0	60.5	55.0	65.9	....
Kentucky	51.4	49.9	51.7	50.0	52.0
Missouri	61.9	....	....	....	....
Montana	45.8	55.3	59.0	58.3	44.7
New Mexico	60.4	56.5	59.4	60.4	53.9
Ohio	69.8	67.2	71.8	67.2	65.4
Oklahoma (Indian Territory)	44.4	52.2	49.4	46.0	....
Pennsylvania	66.3	66.8	66.7	66.8	67.3
Tennessee	54.3	52.0	56.6	54.2	53.1
Virginia	68.6	68.7	68.2	65.1	65.4
Washington	62.0	59.4	60.6	57.1	61.7
West Virginia	63.8	63.8	62.9	63.9	62.0
Maryland			73.0	72.1	67.9
Massachusetts			75.0	76.4	77.7
Michigan			77.0	74.5	74.1
Minnesota	74.7	72.9	68.0	66.4	67.7
New Jersey			80.0	72.3	77.7
New York			72.0	71.3	72.0
Wisconsin			74.0	74.5	76.1
Wyoming			....	....	....
Total average	65.1	65.3	65.8	66.0	66.2

[a] Includes Utah.

Percentage yield of coal in coke, 1880–1909.

1880	63.0	1902	64.1	1906	65.3
1890	64.0	1903	64.1	1907	65.8
1900	63.9	1904	64.8	1908	66.0
1901	63.7	1905	65.1	1909	66.2

CONDITION IN WHICH COAL IS CHARGED INTO THE OVENS.

The statistics of coke production in 1909 show that in addition to the larger quantity of coke made in retort ovens there was another item in which that year made a gain over the high-record year, 1907, and that was in the quantity of coal washed or cleaned before being charged into the coke ovens. To this improvement in methods is probably due some portion of the credit for the increased yield of coal in coke, though to what extent it is due it is not possible to state accurately, for the reason that in some reports received the weight of the coal as charged into the ovens is the weight before washing and in other reports it is the weight after washing. The weight of the coal before or after washing has not been reported on the schedules relating to the manufacture of coke. In the Survey's report on the production of coal for 1909 it is stated that the total quantity of coal washed in that year was 16,541,874 tons, which yielded 14,443,147 tons, or 87.3 per cent of cleaned coal, and 2,098,727 tons of refuse, or 12.7 per cent. In this report, however, are included considerable quantities of coal produced in noncoking-coal States, the coal being washed in order to meet competition, particularly for household use, with better grades of coal. There are, therefore, so many undetermined factors that it is impossible to draw any conclusions as to the influence that the washing of the coal may have had upon the yield of coal in coke.

In 1909 the quantity of coal washed before being used in the manufacture of coke was 11,833,611 short tons, or 19.9 per cent of the total quantity of coal used in coking. How this compares with some earlier years is shown by the fact that in 1890 only 7 per cent of the total quantity of coal used, or 1,269,810 short tons, were washed before being coked. As may be noted in the following table, a much larger percentage of the slack coal used in coke making is washed than of the run-of-mine coal used. In 1909 there were 6,926,484 short tons of slack coal used unwashed, and 5,825,851 tons washed; in the run-of-mine coal there were 40,594,842 tons used unwashed, and 6,007,760 tons washed. It should be stated, however, that a much larger quantity of coal used in the manufacture of coke is reported as mine-run. A large part of this mine-run coal is crushed before being charged into the ovens, as in most cases a superior grade of coke is obtained if the coal is crushed and well mixed before being charged into the ovens. This does not, however, appear as slack coal. The reason that the greater percentage of the slack is washed is that the larger percentage of the impurities occurring in the coal come into the slack, as in the mining operations some of the underclay is naturally taken up into the slack in the undercutting. In the two leading coke-producing States, Pennsylvania and West Virginia, the larger part of the coal used for coking was unwashed, Pennsylvania showing 88.5 per cent of unwashed coal in 1909, and West Virginia 94.6 per cent. In Virginia all of the coal used for coke making was unwashed. In Georgia and in Washington all of the coal used for coke making was washed; in Tennessee 93.8 per cent, in Alabama 85.9 per cent, in Kentucky 84.6 per cent, and in Colorado and Utah 74 per cent of the coal was washed before being charged into the ovens.

The table following shows the quantity of run-of-mine and of slack coal, unwashed and washed, charged into the ovens in 1908 and 1909, by States, and the percentage of each.

Character of coal used in the manufacture of coke, by States and Territories, in 1908 and 1909, in short tons.

1908.

State or Territory.	Run-of-mine.		Slack.		Total.			
	Unwashed.	Washed.	Unwashed.	Washed.	Unwashed.	Percentage.	Washed.	Percentage
Alabama	548,093	1,457,360	53,218	1,817,120	601,311	15.5	3,274,480	84.5
Colorado[a]	0	237,540	407,533	900,971	407,533	26.4	1,138,511	73.6
Georgia	0	0	0	71,452	0	....	71,452	100.0
Illinois	500,400	0	0	2,959	500,400	99.4	2,959	0.6
Kansas	397	0	3,393	0	3,790	100.0	0	....
New Mexico	0	0	0	454,873	0	....	454,873	100.0
Ohio	180,458	27,481	6,244	23,265	186,702	78.6	50,746	21.4
Pennsylvania	18,691,073	1,718,944	1,062,478	1,743,469	19,753,551	85.1	3,462,413	14.9
Tennessee	29,668	250,120	102,578	13,570	132,246	33.4	263,690	66.6
Virginia	1,438,754	0	346,527	0	1,785,281	100.0	0	....
Washington	0	68,069	0	0	0	....	68,069	100.0
West Virginia	1,694,470	35,226	2,206,623	191,411	3,901,093	94.5	226,637	5.5
Indiana								
Kentucky								
Maryland								
Massachusetts								
Michigan								
Minnesota	2,182,415	36,139	777,601	158,945	2,960,016	93.8	195,084	6.2
Montana								
New Jersey								
New York								
Oklahoma								
Wisconsin								
Total	25,265,728	3,830,879	4,966,195	5,378,035	30,231,923	76.7	9,208,914	23.3

1909.

State or Territory.	Run-of-mine.		Slack.		Total.			
	Unwashed.	Washed.	Unwashed.	Washed.	Unwashed.	Percentage.	Washed.	Percentage
Alabama	713,992	2,153,801	0	2,212,971	713,992	14.1	4,366,772	85.9
Colorado[a]	117,446	1,155,233	398,762	313,544	516,208	26.0	1,468,777	74.0
Georgia	0	0	0	86,290	0	....	86,290	100.0
Illinois	1,681,493	0	0	629	1,681,493	99.9	629	0.1
Kentucky	0	0	13,756	75,327	13,756	15.4	75,327	84.6
New Mexico	0	0	182,583	511,807	182,583	26.3	511,807	73.7
Ohio	293,554	0	12,312	34,869	305,866	89.8	34,869	10.2
Pennsylvania	31,712,482	2,278,927	1,016,576	1,975,583	32,729,058	88.5	4,254,510	11.5
Tennessee	30,361	285,591	0	177,331	30,361	6.2	462,922	93.8
Virginia	1,405,111	0	655,407	0	2,060,518	100.0	0	....
Washington	0	69,708	0	0	0	....	69,708	100.0
West Virginia	2,282,403	32,285	3,644,271	402,800	5,926,674	94.6	435,085	5.4
Indiana								
Maryland								
Massachusetts								
Michigan								
Minnesota	2,358,000	32,215	1,002,817	34,700	3,360,817	98.0	66,915	2.0
Montana								
New Jersey								
New York								
Wisconsin								
Total	40,594,842	6,007,760	6,926,484	5,825,851	47,521,326	80.1	11,833,611	19.9

[a] Includes Utah.

In the following table are given the statistics of the character of the coal used in coke making each fifth year since 1890, including 1909:

Character of coal used in the manufacture of coke in the United States, 1890–1909, in short tons.

Year.	Run-of-mine.		Slack.		Total.
	Unwashed.	Washed.	Unwashed.	Washed.	
1890	14,060,907	338,563	2,674,492	931,247	18,005,209
1895	15,609,875	237,468	3,052,246	1,948,734	20,848,323
1900	21,062,090	1,369,698	5,677,006	4,004,749	32,113,543
1905	31,783,314	3,187,994	8,196,226	6,363,143	49,530,677
1909	40,594,842	6,007,760	6,926,484	5,825,851	59,354,937

COKE MAKING IN BY-PRODUCT OVENS.

There was more activity in the construction of by-product recovery ovens in 1909 than for several years past. The 140 additional Koppers regenerative ovens mentioned in the report for 1908 as under construction at Joliet, Ill., doubling the plant at that place, were completed and put in blast, as were also the 50 United-Otto ovens at Kokotto, near Cincinnati, the latter plant also being doubled by this new construction. The 50 United-Otto ovens at Indianapolis were also completed in the latter part of the year, but were not fired up before the 1st of January, 1910. The new construction begun in 1909 and unfinished at the end of the year consisted of 560 Koppers ovens at the Gary, Ind., plant of the United States Steel Corporation; 40 Semet-Solvay ovens at South Chicago, increasing the size of the plant from 160 to 200 ovens; 49 Semet-Solvay ovens at Cleveland, Ohio; and 300 Didier ovens contracted for at Bethlehem, Pa. Altogether there were 949 by-product ovens under construction or contract in 1909, a larger number than at any time since 1903. The 56 ovens of the Newton-Chambers type at Pocahontas, Va., which have not been in practical operation since they were installed, and the 152 ovens of the same type at Vintondale, Pa., that are operated without by-product recovery, have been taken from the list of by-product coking plants. Exclusive of these Newton-Chambers ovens there were 3,799 by-product ovens in the United States at the close of 1908; at the close of 1909 there were 3,989 in existence, a net gain of 190, although 75 ovens, as previously stated, were not in operation during the year. Coke was made in and the by-products were recovered from 3,914 active retort ovens in 1909, as compared with 3,679 active ovens in 1908 and with 3,659 in 1907.

Although the total production of coke in the United States in 1909 was less than in the high-record year 1907, the output from the retort ovens was larger in 1909 than in any preceding year. The production by the 3,914 retort ovens that were in blast in 1909 amounted to 6,254,644 short tons, against 4,201,226 tons in 1908 and 5,607,899 tons in 1907. The increase in 1909 over 1908 was 2,053,418 tons, or nearly 50 per cent, and over 1907 it was 646,745 tons, or 11.5 per cent. The production of beehive coke increased 11,228,129 tons, or 51.4 per cent, over 1908, but was 2,111,244 short tons, or 6 per cent, less than that of 1907. The coke made at by-product ovens in 1909 represented 15.91 per cent of the total production.

The average production from each of the 3,914 active by-product ovens in 1909 was 1,598 short tons of coke, as compared with 1,142 tons per oven in 1908 and with 1,472 tons in 1907. The average production for each beehive oven in 1909 was 361 tons, against 258 tons for each oven in 1908 and 386.8 tons per oven in 1907. The quantity of coal consumed in the manufacture of coke at by-product plants in 1909 was 8,390,129 short tons, and as the output of coke amounted to 6,254,644 tons, the yield of coal in coke was 74.5 per cent. This was an improvement over the result obtained in 1908, when the yield was 73.7 per cent, though not so good as the percentage of 75 made in 1907. All are, however, much larger yields than are obtained in ovens of the beehive type where the process is one of partial combustion and not of distillation and where a portion of the fixed carbon content of the coal is unavoidably consumed; in the retort oven, where the process is conducted without the admission of air, all of the fixed carbon remains as coke. The quantity of coal consumed in beehive ovens in 1909 was 50,964,808 short tons, and the coke produced was 33,060,421 tons, indicating a percentage yield of coal in coke of 64.9. In 1908 the average yield of coal in coke at beehive plants was 64.7 and in 1907 it was 64.6. The value of the 8,390,129 tons of coal used in retort ovens in 1909 was $18,557,164, or $2.21 per ton, and the value of the 50,964,808 tons used in beehive ovens was $43,646,218, an average of $0.856 per ton, the variance in the two being due to the freight charges on the coal from the mines to the retort-oven plants.

The operations of the Koppers regenerative ovens at Joliet and of the Semet-Solvay ovens at South Chicago in 1909 have placed Illinois among the six leading coke-producing States, with a production during that year of 1,276,956 short tons. When the new plant at Gary is completed and the plant at Indianapolis put in blast Indiana will also take rank among the leading coke-producing States. The coal for all of these ovens in Illinois has been, and that for the ovens in Indiana will be, drawn from the mines of West Virginia, and not from the mines of the States in which the ovens are located.

The value of the 6,254,644 tons of coke produced at retort ovens in the United States in 1909 was $20,434,689, or an average of $3.27 per ton. The value of the 33,060,421 tons of beehive coke produced was $69,530,794, an average of $2.10 per ton. The reason for the higher relative value of by-product coke is that the ovens are located at distances from the coal mines and the expenses of transportation have been borne by the coal. If the expense of transportation were added to the value of the beehive coke and the values were given at the point of consumption, the difference in value would probably be in favor of the beehive ovens.

The total value of the by-products obtained from the manufacture of coke in retort ovens in 1909 amounted to $8,073,948, as compared with $7,382,299 worth of by-products recovered in 1908 and with $7,548,071 in 1907. The by-products recovered in 1909 consisted of 15,791,220 thousand cubic feet of surplus gas, valued at $2,609,211; 60,126,006 gallons of tar, valued at $1,408,611; 123,111,197 pounds of ammonium sulphate (or liquor or anhydrous ammonia reduced to equivalent in sulphate), valued at $3,227,316; and 4,871,014 pounds of anhydrous ammonia (sold as such), valued at $448,455. "Other products," consisting of light and secondary oils and small quantities of coke breeze and ammonia liquor, had a total value of $380,355.

There are a few plants in the United States in which the heated gases from the coke ovens are utilized for the generation of power, but where no attempt is made to recover the by-products. Some of these, notably the plant of the Stag Cañon Fuel Company, at Dawson, N. Mex., are of the beehive type provided with flues that convey the still burning gases to the power houses. Some are of the Belgian type—retort ovens heated by flues—the surplus heat being utilized in the generation of power. Recent experience along these lines at Las Esperanzas, Mexico, is of interest as illustrating the economies to be effected in retort ovens even without the recovery of by-products. There is no market for the tar, gas, or ammonia; and by-product recovery would therefore mean additional expense in construction and operation without increase in revenue. The writer has been informed by Mr. Edwin Ludlow, general manager of the Mexican Coal and Coke Company at Las Esperanzas, that in the operation of the Belgian ovens an increase of 10 is made in the percentage yield of coal in coke and that a decided improvement in the quality of the coke has been attained. The gases from the distillation of the coal, after first passing through the flues for the heating of the ovens, are passed through a main flue to the power house. All the power necessary for the operation of the mines, washery, etc., is obtained from the oven gases, it being estimated that each oven produces an average of 15 horsepower. Applying this average to the more than 90,000 beehive ovens in the United States, it would appear that 1,350,000 horsepower is going to waste in the coking regions of the United States every day in the year. In the Connellsville and Lower Connellsville districts of Pennsylvania the energy available from the 38,000 ovens would exceed 570,000 horsepower.

In the report for 1907 some deductions were made as to the value of the by-products recoverable from the coal used in coke making and wasted in beehive-oven practice. It was then shown that $38,000,000, less differences in cost of operating retort and beehive plants, wear and tear, interest on capital, etc., represented the charge on the debit side of the conservation account from the coke made in beehive ovens in the United States in that year. The corresponding figures with the reduced production in 1908 were approximately $27,000,000, and in 1909 they were about $35,000,000.

The total value of the coke, gas, tar, ammonia, and other products produced at by-product recovery ovens in 1909 was $8,073,948, as compared with $7,382,299 in 1908 and with $7,548,071 in 1907. The totals were made up as follows:

Value of products obtained in manufacture of coke in retort ovens in 1907, 1908, and 1909.

	1907.		1908.		1909.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Gas.......M cubic feet..	20,516,731	$3,130,839	16,205,925	$2,557,483	15,791,220	$2,609,211
Tar............gallons..	53,995,795	1,242,530	42,720,609	1,007,613	60,126,006	1,408,611
Ammonia, sulphate or reduced to equivalent in sulphate...pounds..	125,372,360	3,174,702	43,329,426	1,286,224	123,111,197	3,227,316
Anhydrous ammonia ....pounds..	....	....	15,445,030	2,530,979	4,871,014	448,455
All other products......	....	....	....	....	....	380,355
Total value of by-products........	....	7,548,071	....	7,382,299	....	8,073,948
Coke........short tons..	5,607,899	21,665,157	4,201,226	14,465,429	6,254,644	20,434,689
Grand total.......	....	29,213,228	....	21,847,728	....	28,508,637

The gas included in the foregoing statement is the "surplus" not consumed in the coking process, which is either sold or used at manufacturing establishments operated in connection with the coke-oven plant. In a few establishments where the surplus gas was consumed by the producing companies, the quantity was not measured nor was any value placed upon it in the reports made to the Geological Survey. For such establishments careful estimates have been made, based upon the average surplus gas obtained from similar coals used at ovens of the same type. The value, similarly estimated, has been placed at from 10 to 15 cents per thousand cubic feet.

According to W. Galloway,[a] patents on coke ovens with recovery of by-products were issued in England as early as 1773 and again in 1782. It was not until one hundred and eleven years after the latter date, or in 1893, that the first plant of by-product recovery ovens was completed in the United States. This was a bank of 12 Semet-Solvay ovens at Syracuse, N. Y. In the first year of their operation these ovens produced 12,850 short tons of coke. This plant has since been increased to 40 ovens. The first plant of United-Otto (Otto-Hoffmann) ovens was one of 60 units, constructed at Johnstown, Pa., and operated in connection with the iron and steel works of the (now) Cambria Steel Company; this plant has since been enlarged several times and now contains a total of 372 ovens. An experimental plant of Newton-Chambers ovens was built at Latrobe, Pa., about ten years ago, but was never operated. These ovens were afterwards torn down and rebuilt at Pocahontas, Va., in 1900, but have not been in blast except for a short time immediately after completion. In 1907 a bank of this type of oven, 152 in number, was begun at Vintondale, Pa. The ovens were completed and put in blast in 1907, but as neither this plant nor the one at Pocahontas has ever been operated for by-product recovery, they have been taken from the list of by-product ovens. In 1904 the Lackawanna Steel Company constructed a plant of 94 Rothberg ovens at Buffalo, N. Y.; this plant has since been enlarged to 282 ovens. The first establishment of Koppers regenerative ovens was begun in 1907 by the Illinois Steel

[a] The genesis and development of the coking oven: Proc. South Wales Inst. England, vol. 26, 1909.

Company at Joliet, Ill.; it consists of 280 ovens, 140 of which were finished and put in blast in 1908, and the second installment was completed and put in blast in 1909. It is apparent that this plant has yielded satisfactory results, for the United States Steel Corporation began in 1909 an additional plant of 560 Koppers ovens at its new town of Gary, Ind. Other new work begun in 1909 was 40 Semet-Solvay ovens in addition to the 160 already constructed at South Chicago, Ill., and 49 Semet-Solvay ovens at Cleveland, Ohio, to take the place of 80 Rothberg ovens dismantled. The Didier-March Company, backed by German and American capital, began the construction of 300 by-product ovens at Bethlehem, Pa. At the close of 1909 there were a total of 3,989 by-product ovens in existence, all but 75 of which were in operation during the year. On December 31, 1909, there were 949 ovens in course of construction. The development of the by-product recovery coking process in the United States since 1893 is shown in the following table:

Record of by-product coke making, 1893–1909.

Year.	Ovens.		Production (short tons).	Year.	Ovens.		Production (short tons).
	Built.	Building.			Built.	Building.	
1893	12	0	12,850	1902	1,663	1,346	1,403,588
1894	12	60	16,500	1903	1,956	1,335	1,882,394
1895	72	60	18,521	1904	2,910	832	2,608,229
1896	160	120	83,038	1905	3,103	417	3,462,348
1897	280	240	261,912	1906	3,547	112	4,558,127
1898	520	500	294,445	1907	3,684	330	5,607,899
1899	1,020	65	906,534	1908	3,799	240	4,201,226
1900	1,085	1,096	1,075,727	1909	[a] 3,989	[b] 949	6,254,644
1901	1,165	1,533	1,179,900				

[a] Includes 1,298 Semet-Solvay, 2,104 United-Otto, 307 Rothberg, and 280 Koppers ovens.
[b] Includes 560 Koppers, 89 Semet-Solvay ovens, and 300 Didier ovens contracted for.

In the following table is shown the record of by-product coke ovens, by States, at the close of 1905–1909:

Record of by-product ovens, by States, 1905–1909.

State.	Dec. 31, 1905.		Dec. 31, 1906.		Dec. 31, 1907.		Dec. 31, 1908.		Dec. 31, 1909.	
	Built.	Building.	Built.	Building.	Built.	Building.	Built.	Building.	Built.	Building.
Alabama	280	0	280	0	280	0	280	0	280	0
Illinois	120	0	160	0	160	280	300	140	440	40
Indiana	.....	.....	.....	.....	.....	.....	.....	50	50	560
Maryland	200	0	200	0	200	0	200	0	200	0
Massachusetts	400	0	400	0	400	0	400	0	400	0
Michigan	135	15	150	0	150	0	150	0	162	0
Minnesota	50	0	50	0	50	0	50	0	50	0
New Jersey	100	50	150	0	150	0	150	0	150	0
New York	399	0	540	0	540	0	540	0	556	0
Ohio	130	0	130	0	155	50	155	50	125	49
Pennsylvania	1,089	272	1,207	112	1,319	0	1,294	0	1,296	[a] 300
West Virginia	120	0	120	0	120	0	120	0	120	0
Wisconsin	80	80	160	0	160	0	160	0	160	0
Total	3,103	417	3,547	112	3,684	330	3,799	240	3,989	949

[a] Contracted for; construction begun in 1910.

The distribution, by States and by kinds, of by-product ovens built and building in the United States at the close of 1909 is shown in the following table:

Kinds of by-product coke ovens built and building in the United States, by States, at the close of 1909.

State.	United-Otto.[a]	Semet-Solvay.	Roth-berg.	Kop-pers.	Total.	
	Built.	Built.	Built.	Built.	Built.	Building.
Alabama		280			280	
Illinois		160		280	440	[b] 40
Indiana	50				50	[c] 560
Maryland	200				200	
Massachusetts	400				400	
Michigan	30	132			162	
Minnesota	50				50	
New Jersey	150				150	
New York	188	86	282		556	
Ohio	100		25		125	[b] 49
Pennsylvania	936	360			1,296	[d] 300
West Virginia		120			120	
Wisconsin		160			160	
Total	2,104	1,298	307	280	3,989	949

[a] Includes the Otto-Hoffmann and Schniewind types.
[b] Semet-Solvay ovens.
[c] Koppers ovens.
[d] Didier ovens under contract.

The table following, originally compiled by Mr. Albert Ladd Colby, consulting engineer, South Bethlehem, Pa., was first published in the report for 1906. It has since been revised by Mr. Colby, and also by Mr. C. G. Atwater, of the United Coke and Gas Company, Whitehall Building New York City, and by Mr. W. H. Blauvelt, of the Semet-Solvay Company, Syracuse, N. Y.

This table shows, in addition to the number of ovens at each by-product coke-oven plant in the United States and Canada, the uses to which the coke and gas are put, the dates the plants were put in operation, and other interesting information regarding their construction and operation.

Complete list of by-product and retort coke-oven plants of the United States and Canada, January 1, 1910.

State.	Town.	System.	Name of company owning plant.	Number of installments.	Date put in operation.	Number of ovens.	Uses of coke.	Uses of surplus gas.	Remarks.
Mass	Everett	Otto-Hoffmann	New England Gas and Coke Co.		June, 1899	400	Domestic, industrial, and locomotive in about equal proportion.	Illuminating gas and fuel gas; 6,500,000 to 7,500,000 cubic feet daily of illuminating gas.	First illuminating-gas system installed.
N. Y.	Syracuse	Semet-Solvay	Solvay Process Co.	First	Jan., 1893	12	Burning limestone: also iron foundry.	Fuel	First by-product plant in United States. Main purpose originally to obtain ammonia for alkali works.
				Second	1896	a 25			
				Third	Bet. 1900–1903.	a 40			
	Geneva	do	The Empire Coke Co.	First	Aug., 1904	30	Foundry and domestic.	Illuminating	
				Second	1909	a 46			
	Buffalo	United-Otto	Lackawanna Steel Co.	First	May, 1904	b 564	Blast furnace	Fuel gas	First used stamped coal, but changed to top-charging, 1907.
	do	Rothberg	do	do		282	do	do	
N. J.	Camden	Otto-Hoffmann	Camden Coke Co.	do	About Jan., 1903.	100	Blast furnace. Foundry and domestic (domestic coke crushed and sized for sale).	Illuminating gas and fuel gas 2,500,000 to 3,000,000 cubic feet. Illuminating gas pumped daily under 10 pounds pressure to Trenton, 38 miles distant. In 1906 extended delivery of illuminating gas to New Brunswick and Plainfield, 83 miles from Camden. Towns now included: Camden, Bordentown, Woodbury, Trenton, New Brunswick, Plainfield, and smaller towns.	First to install enrichment by benzol transfer.
	do	United-Otto	do	Second	July, 1906	50			
Pa.	Dunbar	Semet-Solvay	The Dunbar Furnace Co.	First	Aug., 1896	50	Blast furnace	Fuel gas	
				Second	July, 1903	60			
	Chester	do	The Suburban Gas and Electric Co.	First	Apr., 1904	40	Blast furnace	Illuminating	
	Sharon	do	F. H. Buhl Coke Works.	do	Oct., 1896	25	do	Fuel gas	Dismantled.
	South Sharon	United-Otto	Carnegie Steel Co.	do	July, 1903	212	do	do	
	Glassport	Otto-Hoffmann	United Coke and Gas Co.		Feb., 1897	120	Blast furnace and domestic. Installed a crushing outfit in 1905.	Illuminating gas and fuel gas to McKeesport.	

	Johnstown	do	Cambria Steel Co.	First	Nov., 1895	60	Blast furnace	Fuel gas and power gas	
	do	United-Otto	do	Second	Mar., 1899	100	do	do	
	do	do	do	Third	Sept., 1904	100	do	do	
	do	do	do	Fourth	Feb., 1907	112	do	do	
	Lebanon	Semet-Solvay	Pennsylvania Steel Co.	First	July, 1904	90	do	Semet-Solvay Co. delivers surplus gas to Pennsylvania Steel Co., which sells it to American Iron and Steel Mfg. Co. for use in heating furnaces and gas engine. Also four gas engines 1,200 H. P. each, furnishing power for generating electricity to operate Cornwall Ore Banks, at Lebanon, Pa.	This last gas-engine installation is the largest one in the United States using coke-oven gas.
	do	Otto-Hoffmann.	Lackawanna Iron and Steel Co.	do	Mar., 1903	232	do	Fuel gas	Went back to top-charging since resumption in September, 1905. The 5 Rothberg ovens were shut down in August, 1903, and have since been dismantled.
	do	Rothberg	do	do	May, 1903	5			
	Steelton	Semet-Solvay	Pennsylvania Steel Co.	do	Jan., 1907	120	Blast furnace	Fuel gas	
	South Bethlehem.	Didier	Lehigh Coke Co.	do	Not completed.	300			
W. Va.	Benwood	Semet-Solvay	National Tube Co.	do	Oct., 1898	60	Blast furnace	Fuel gas	
				Second	Mar., 1901	60	do	do	
Md.	Sparrows Point.	United-Otto	Maryland Steel Co.	First	Mar., 1903	200	do	Illuminating gas for city of Baltimore, 11 miles distant; 4,000,000 cubic feet daily.	
Ala.	Ensley (near Birmingham).	Semet-Solvay	Tennessee, Coal, Iron, and R. R. Co.	do	Oct., 1898	120	do	Fuel gas	
				Second	Mar., 1902	120	do	do	
	Tuscaloosa	do	Central Iron and Coal Co.	First	Feb., 1906	40	do	do	
Ohio	Hamilton	Otto-Hoffmann.	Hamilton Otto Coke Co.	do	Apr., 1901	50	Mostly domestic; some foundry. Installed crushing outfit 1905.	Illuminating gas for Hamilton; also power gas.	
	do	United-Otto	do	Second	1909	50	Blast furnace	do	
	Cleveland	Rothberg	Retort-Coke Oven Co.	First	About Apr. 1905.	80	do	Fuel gas	Used stamped coal, side charged; now being dismantled and reconstructed into 49 Semet-Solvay ovens.
	do	do	do	Second	Oct., 1907	25	do	do	Plant closed down March, 1908.
Ind.	Indianapolis	United-Otto	Citizens Gas Co.	First	Completed, 1909.	50	Blast furnace and foundry.	Illuminating gas for Indianapolis.	

a Increased to.

b Contracted for; 188 completed.

Complete list of by-product and retort coke-oven plants of the United States and Canada, January 1, 1910—Continued.

State.	Town.	System.	Name of company owning plant.	Number of installments.	Date put in operation.	Number of ovens.	Uses of coke.	Uses of surplus gas.	Remarks.
Ind.	Gary	Koppers	Illinois Steel Co.	First	Not completed.	560	Blast furnace		
Ill.	Joliet	do	do	do	Completed in 1908.	140	do	Fuel and power	
	do	do	do	Second	In blast Mar., 1909.	140	do	do	
	South Chicago, on Calumet River.	Semet-Solvay	By-products Coke Corporation.	First	Dec., 1905	120	Blast furnace, foundry, and domestic.	Illuminating	
				Second	Dec., 1906	40			
				Third	Not completed.	40			
Wis.	Milwaukee	Semet-Solvay	Milwaukee Coke and Gas Co.	First	Mar., 1904	80	Blast furnace, foundry, and domestic.	Illuminating	
	do	do	do	Second	Mar., 1906	80			
Mich.	Delray	do	The Solvay Process Co.	First	Sept., 1901	30	Furnace, foundry, domestic, and lime-burning.	Illuminating	
				Second	Nov., 1902	30			
				Third	Mar., 1906	60			
				Fourth	1909	12			
	Wyandotte	United-Otto	Michigan Alkali Co.	First	Oct., 1902	15	Burning limestone.	Fuel gas	Use the by-products in their works.
				Second	Aug., 1906	15			
Minn.	Duluth	do	Zenith Furnace Co.	First	July, 1904	50	Blast furnace	Illuminating gas for Duluth.	
Nova Scotia.	Halifax	Semet-Solvay	People's Heat and Light Co.		Apr., 1898	10	Domestic	Illuminating gas for Halifax.	Originally the Slocum oven. Not in operation.
	Sydney	Otto-Hoffmann	Dominion Iron and Steel Co.		Dec., 1900	500	Blast furnace	Fuel gas	
	Sydney mines	von Bauer	Nova Scotia Steel and Coal Co. (Limited).		1900	30	do		Non-by-product ovens.
	do	Bernard	do		1902	120	do		Do.

NOTES.—1. Of the 13 plants of Semet-Solvay ovens in the United States, 2 are owned by the Solvay Process Company, and the other 11 are operated by the Semet-Solvay Company, the coke produced being turned over to the company whose name appears as owner.
2. Tar and ammonia are recovered as by-products from all of the plants included in the above table, except that of the Nova Scotia Steel and Coal Company (Limited).

IMPORTS AND EXPORTS.

IMPORTS.

The following table gives the quantity and value of coke imported and entered for consumption in the United States from 1904 to 1909, inclusive. In the reports of the Bureau of Statistics of the Department of Commerce and Labor, from which these figures are obtained, the quantities are expressed in long tons of 2,240 pounds. These have been reduced to short tons in order to make them conform to the standard unit of this report.

Coke imported and entered for consumption in the United States, 1904–1909, in short tons.

1904	180,855	$648,521	1907	135,968	$596,366
1905	203,142	796,545	1908	147,427	606,294
1906	147,819	570,150	1909	191,253	736,120

EXPORTS.

The quantity of coke exported from the United States increased each year from 1900 to 1907, but decreased in 1908, increasing again in 1909. The exports for the last six years are shown in the following table, the quantities in this case also being reduced to short tons:

Coke exported from the United States since 1904, in short tons.

1904	585,861	$2,311,401	1907	979,652	$3,206,793
1905	670,939	2,243,010	1908	695,434	2,161,032
1906	857,013	2,753,551	1909	1,002,916	3,232,673

IMPORTS OF COAL-TAR PRODUCTS.

It has been contended that the development of the by-product coking industry would have shown more rapid progress if markets for the by-products were assured. This contention pertains essentially to the coal tar and its products, as there is no difficulty in disposing of the surplus gas and there is practically at all times a fair demand for ammonia. As to the coal tar, the total value of this by-product from retort ovens at first hand in 1909 was $1,408,611. The value of the coal-tar products imported into this country in 1909, including duty paid, was $11,899,774. The values in all cases of imports are at point of shipment, and do not include ocean freights, commissions, and other expenses. It is probable that these importations have reached the consumer at a total cost of not less than $15,000,000. The kinds of coal-tar products imported, the value thereof, and the amount of duty paid on each during the last five years are shown in the following table:

Coal-tar products imported into the United States, 1905–1909.

Year.	Salicylic acid.		Alizarin and colors or dyes, natural and artificial.		Aniline salts.		Coal-tar colors or dyes, not specially provided for.	
	Value.	Duty.	Value.	Duty.	Value.	Duty.	Value.	Duty.
1905	$2,214	$923	$625,491	Free.	$789,052	Free.	$5,673,242	$1,701,973
1906	2,772	991	661,155	Free.	806,901	Free.	5,717,932	1,715,380
1907	1,240	489	782,368	Free.	667,758	Free.	5,830,651	1,749,196
1908	1,183	345	752,386	Free.	450,891	Free.	4,573,217	1,371,965
1909	....	....	1,191,874	Free.	553,503	Free.	6,431,767	1,929,530

Coal-tar products imported into the United States, 1905–1909—Continued.

Year.	Coal tar, all preparations, not colors or dyes.		Coal-tar products not medicinal, not dyes, known as benzol, toluol, etc.		Total.	
	Value.	Duty.	Value.	Duty.	Value.	Duty.
1905	$768,556	$153,711	$486,439	Free.	$8,344,994	$1,856,607
1906	864,067	172,814	483,416	Free.	8,536,243	1,889,185
1907	911,096	182,219	653,288	Free.	8,846,401	1,931,904
1908	717,556	143,511	549,352	Free.	7,044,585	1,515,821
1909	693,608	138,768	960,724	Free.	9,831,476	2,068,298

PRODUCTION OF COKE BY STATES.

ALABAMA.

Although the production of coke in Alabama in 1909 exceeded that of 1907 and of any preceding year in the history of the State, it was not sufficient to reestablish Alabama as second in importance among the coke-producing States. For the last five years West Virginia has ranked next to Pennsylvania in the manufacture of coke, and will probably continue to do so in the future. In respect to the value of the product, however, Alabama still retains the advantage over West Virginia. Having in the iron furnaces of Birmingham and vicinity a home market for its product of coke, Alabama coke commands a higher price at the ovens than does that of West Virginia, which is shipped to distant points for consumption. In 1909 the quantity of coke manufactured in Alabama was 3,085,824 short tons, valued at $8,068,267. The quantity of coke manufactured in West Virginia was 3,943,948, but the value was only $7,525,922. The average price for Alabama coke in 1909 was $2.61; that for the product from the West Virginia ovens was $1.99. Compared with the production of coke in Alabama in 1908, when it was 2,362,666 short tons, valued at $7,169,901, the production of coke in Alabama in 1909 showed an increase of 723,158 short tons, or 30.61 per cent, in quantity and of $898,366, or 12.53 per cent, in value. When the production of 1909 is compared with that of 1907 it is seen that the quantity of coke increased 64,030 short tons and that the value decreased $1,147,927. The average price per ton declined from $3.05 in 1907 to $3.04 in 1908 and to $2.61 in 1909. Of the total quantity of coke produced in 1909 in Alabama, 533,903 short tons were made in by-product recovery ovens, of which there are 2 establishments in the State, 1 of 240 ovens at Ensley, and 1 of 40 ovens at Tuscaloosa, all Semet-Solvay ovens. There were 43 establishments in Alabama in 1909, an apparent decrease of 2 from 1908. The difference in the number of establishments, however, is due to the consolidation of 4 establishments in 1908 into 2 in 1909. There were 42 ovens abandoned during 1909, and the total number of ovens decreased from 10,103 to 10,061. Of the 43 establishments, 6 with a total of 713 ovens were idle during the entire year 1909. There were no new ovens building at the close of either 1908 or 1909. The average production from the 9,348 ovens that were active for the whole or a portion of 1909 was 330 short tons.

The production of coke in Alabama in 1880, 1890, 1900, and from 1905 to 1909, is shown in the following table:

Statistics of the manufacture of coke in Alabama, 1880–1909.

Year.	Establishments.	Ovens.		Coal used (short tons).	Coke produced (short tons).	Total value of coke at ovens.	Value of coke at ovens, per ton.	Yield of coal in coke (per cent).
		Built.	Building.					
1880	4	316	100	106,283	60,781	$183,063	$3.01	57.0
1890	20	4,805	371	1,809,964	1,072,942	2,589,447	2.41	59.0
1900	30	6,529	690	3,582,547	2,110,837	5,629,423	2.67	58.9
1905	42	9,586	150	4,409,854	2,576,986	7,646,957	2.97	58.4
1906	42	9,731	160	5,184,597	3,034,501	8,477,899	2.79	58.5
1907	43	9,889	50	4,973,296	3,021,794	9,216,194	3.05	61.0
1908	45	10,103	0	3,875,791	2,362,666	7,169,901	3.04	61.0
1909	43	[a]10,061	0	5,080,764	3,085,824	8,068,267	2.61	60.7

[a] Includes 280 Semet-Solvay ovens.

Of the 5,080,764 tons of coal used in 1909 in the manufacture of coke 85.9 per cent was washed before being charged into the ovens. All of the slack—2,212,971 tons—used for coke making was washed, and of the 2,867,793 tons of run-of-mine coal used, 2,153,801 tons, or 75 per cent, were washed, and 713,992, or 25 per cent, were unwashed. The character of the coal used in the manufacture of coke in Alabama in 1890, 1900, and for the last five years, is shown in the following table:

Character of coal used in the manufacture of coke in Alabama, 1890–1909, in short tons.

Year.	Run of mine.		Slack.		Total
	Unwashed.	Washed.	Unwashed.	Washed.	
1890	1,480,669	0	206,106	123,189	1,809,964
1900	1,729,882	152,077	165,418	1,535,170	3,582,547
1905	1,297,376	1,247,924	0	1,864,554	4,409,854
1906	1,493,549	1,810,089	121,122	1,759,837	5,184,597
1907	1,020,907	1,697,913	27,433	2,227,043	4,973,296
1908	548,093	1,457,360	53,218	1,817,120	3,875,791
1909	713,992	2,153,801	0	2,212,971	5,080,764

COLORADO AND UTAH.

The statistics of the manufacture of coke in Colorado and Utah are combined in order not to divulge individual operations, there being but two establishments in Utah, both of which are owned by one company. The production of the two States in 1909 amounted to 1,251,805 short tons, valued at $4,135,931, against 982,291 short tons, valued at $3,238,888, in 1908, and 1,421,579 short tons, valued at $4,747,436, in 1907. The increase in 1909 as compared with 1908 was 269,514 short tons, or 27.44 per cent, in quantity, and $897,043, or 27.70 per cent, in value, the percentage of increase in value being slightly in excess of the percentage of increase in quantity. In this respect the production of coke in Colorado and Utah was essentially different from that in most of the other coke-manufacturing States, and was due to the revival in the metal-mining industry in the Rocky Mountain States and to the fact that the coke made in Colorado and Utah is not sold on contract prices to such an extent as obtains in the Eastern States. The difference in the average price between 1908 and 1909 was less than half of 1 cent per ton. There were 18 establishments in the two States in 1909, the same as in 1908. Five of these, with a total of 726 ovens, were idle in 1909. There were five ovens abandoned during the year, and there were no new ovens constructed. The total number of ovens decreased from 4,705 in 1908 to 4,700 in 1909.

The statistics of the manufacture of coke in Colorado and Utah in 1880, 1890, 1900, and for the last five years are shown in the following table:

Statistics of the manufacture of coke in Colorado and Utah, 1880–1909.

Year.	Establishments.	Ovens.		Coal used (short tons).	Coke produced (short tons).	Total value of coke at ovens.	Value of coke at ovens, per ton.	Yield of coal in coke (per cent).
		Built.	Building.					
1880	1	200	50	51,891	25,568	$145,226	$5.68	49.0
1890	8	916	30	407,023	245,756	959,246	3.90	60.0
1900	14	1,692	0	997,861	618,755	1,746,732	2.82	62.0
1905	17	3,925	150	2,368,365	1,378,824	4,157,517	3.02	58.2
1906	17	4,103	250	2,566,196	1,455,905	4,504,748	3.09	56.7
1907	18	4,683	50	2,388,911	1,421,579	4,747,436	3.34	59.5
1908	18	4,705	0	1,546,044	982,291	3,238,888	3.30	63.5
1909	18	4,700	0	1,984,985	1,251,805	4,135,931	3.30	63.1

It appears from the statement in the following table that a much larger quantity of run-of-mine coal was used in 1909 than in 1908. This is probably because some coal used in 1908 was crushed for washing and coking and was reported as slack coal rather than mine-run. Of the total quantity of coal used in 1909—1,984,985 tons—1,468,777 tons were washed and 516,208 tons were unwashed. Of the washed coal used 313,544 tons were reported as slack and 1,155,233 as mine-run; of the unwashed coal used 398,762 tons were slack and 117,446 tons were mine-run.

The character of the coal used in the manufacture of coke in Colorado and Utah in 1890, 1900, and for the last five years is shown in the following table:

Character of coal used in the manufacture of coke in Colorado and Utah, 1890–1909.

Year.	Run-of-mine.		Slack.		Total.
	Unwashed.	Washed.	Unwashed.	Washed.	
1890	36,058	0	395,023	0	431,081
1900	229,311	0	316,527	452,023	997,861
1905	0	0	691,982	1,676,383	2,368,365
1906	4,866	703,440	1,065,353	792,537	2,566,196
1907	2,956	676,226	1,055,189	654,540	2,388,911
1908	0	237,540	407,533	900,971	1,546,044
1909	117,446	1,155,233	398,762	313,544	1,984,985

GEORGIA.

Dade County, in the extreme northwest corner of Georgia, contains a small area of the Walden Ridge (Tennessee) coal basin, and a portion of the adjoining county of Walker is underlain by an extension of the beds of Lookout Mountain of Alabama. Coal mining on an extensive scale is carried on in both counties, and a good grade of coke is made from the slack coal produced in mining. The iron furnaces in and near Chattanooga, Tenn., furnish the principal market for the coke. All of the coal used in coking was washed before being charged into the ovens.

There are only two establishments in the State, and one of these has been idle for the last two years. The statistics of production at the plant of the Durham Coal and Coke Company are published with the definite permission so to do. The total production in 1909 amounted to 46,385 short tons, valued at $159,334, as against 39,422 short tons, valued at $137,524, in 1908. The average price declined from $3.72 in 1908 to $3.44 in 1909.

The statistics of the manufacture of coke in Georgia in 1880, 1890, 1900, and from 1905 to 1909 are shown in the following table:

Statistics of the manufacture of coke in Georgia, 1880–1909.

Year.	Establishments.	Ovens.		Coal used (short tons).	Coke produced (short tons).	Total value of coke at ovens.	Value of coke at ovens, per ton.	Yield of coal in coke (per cent).
		Built.	Building.					
1880	1	140	40	63,402	38,041	$81,789	$2.15	60.0
1890	1	300	0	170,388	102,233	150,995	1.48	60.0
1900	2	480	0	140,988	73,928	210,646	2.85	52.4
1905	2	533	0	119,036	70,593	224,260	3.18	59.3
1906	2	531	0	128,052	70,280	277,921	3.95	54.9
1907	2	350	0	136,031	74,934	315,371	4.21	55.1
1908	2	350	0	71,452	39,422	137,524	3.72	55.2
1909	2	350	0	86,290	46,385	159,334	3.44	53.8

ILLINOIS.

As noted in the report for 1908, Illinois has become prominent in the manufacture of coke through the construction in 1906 of 160 Semet-Solvay ovens at South Chicago, and of 280 Koppers regenerative ovens at Joliet, the latter having been constructed by the Illinois Steel Company. Of the Koppers ovens 140 were not put in blast until 1909. The coal for all of these ovens is drawn from the mines of West Virginia and not from those of Illinois. As a result of the operations of these two plants the production of coke in Illinois increased from 362,182 short tons in 1908 to 1,276,956 tons in 1909, an increase of 914,774 tons, or 252.57 per cent, and the value increased from $1,538,952 in 1908 to $5,361,510 in 1909, a gain of $3,822,558, or 248.39 per cent. It is also to be noted that Illinois advanced from ninth to fifth place in the rank of coke-producing States. The only other establishment besides those at South Chicago and Joliet in operation in 1909 was the Gallatin Coal and Coke Company, of Equality, which makes coke in Belgian ovens from Illinois coal. The production from this establishment, however, is small, and as by far the larger part of the coke output is made in by-product recovery ovens, the percentage yield of coal in coke for the State was 76, or 10 more than the average for the United States of 66 per cent. At the close of 1909 there was under construction an additional bank of 40 Semet-Solvay ovens for the South Chicago plant.

The statistics of the manufacture of coke in Illinois during the last five years are shown in the following table:

Statistics of the manufacture of coke in Illinois, 1905–1909.

Year.	Establishments.	Ovens.		Coal used (short tons).	Coke produced (short tons).	Total value of coke at ovens.	Value of coke at ovens, per ton.	Yield of coal in coke (per cent).
		Built.	Building.					
1905	5	275	0	16,821	10,307	27,681	2.685	61.3
1906	4	309	0	362,163	268,693	1,205,462	4.48	74.2
1907	5	309	280	514,983	372,697	1,737,464	4.66	72.3
1908	6	430	140	503,359	362,182	1,538,952	4.25	72.0
1909	5	[a] 468	[b] 40	1,682,122	1,276,956	5,361,510	4.20	75.9

[a] Includes 160 Semet-Solvay and 280 Koppers ovens. [b] Semet-Solvay ovens.

INDIANA.

Mention was made in the report for 1908 of a bank of 10 ovens being constructed in Indiana during that year by the United Fourth Vein Coal Company at Black Creek, Greene County. The 36 ovens formerly operated by the Ayrshire Coal Company at Ayrshire have not been in blast for several years. The 10 ovens at Black Creek produced a small quantity of coke in 1909, using unwashed Indiana slack coal. The Citizens Gas Company, of Indianapolis, began the construction of 50 United-Otto ovens in 1908; although they were completed before the close of 1909 they were not put in blast until after the 1st of January, 1910. During 1909 the United States Steel Corporation began the construction at Gary of 560 Koppers ovens, to be operated in connection with its new steel plant at that place. The coal for these ovens will probably be drawn from the mines operated by a subsidiary company of the Steel Corporation in West Virginia. When these ovens are put in blast, they will make Indiana one of the more important coke-manufacturing States.

KANSAS.

All of the coke made in Kansas is used for zinc smelting, and the ovens are operated in connection with the zinc works. The ovens are charged with slack obtained in the vicinity of Pittsburg, in Crawford County, and all of this slack is used unwashed, as the zinc smelters do not require a high-grade coke. The industry has never been of much importance, the largest production of 20,902 tons having been obtained in 1902, since which time it has shown a tendency to decline. The production decreased to 1,698 tons in 1906, but revived somewhat with the industrial activity of 1907 to 6,274 tons. In 1908 the production again decreased to 2,497 tons, and in 1909 all of the plants were idle, so that no production of coke was reported from the State in that year.

The statistics of the manufacture of coke in this State in 1880, 1890, 1900, and from 1905 to 1909 are shown in the following table:

Statistics of the manufacture of coke in Kansas, 1880–1909.

Year.	Establishments.	Ovens.		Coal used (short tons).	Coke produced (short tons).	Total value of coke at ovens.	Value of coke at ovens, per ton.	Yield of coal in coke (per cent).
		Built.	Building.					
1880	2	6	0	4,800	3,070	$6,000	$1.95	64.0
1890	7	68	0	21,809	12,311	29,116	2.37	56.0
1900	9	91	0	10,303	5,948	14,985	2.52	57.7
1905	6	91	0	6,504	4,425	13,818	3.12	68.0
1906	5	81	0	2,807	1,698	4,101	2.42	60.5
1907	6	83	0	11,392	6,274	19,837	3.16	55.0
1908	6	67	0	3,790	2,497	8,011	3.21	65.9
1909	6	67	0	0	0	0	0	0

KENTUCKY.

Kentucky is the only one of the United States whose coal supplies are drawn from any two of the great fields. The eastern counties of the State are underlain by the coal measures of the Appalachian region, and the southern extremity of the eastern interior, or Illinois-Indiana field, is worked extensively in the western part of Kentucky. Coke has been made from coal mined in both the eastern and the western parts of the State; but, although the coals of the eastern counties are in large part included among the high-grade coking coals of the Appalachian field and although little or no coke is made from the coals of the eastern interior field in Illinois or Indiana, all of the coke made in Kentucky in 1907 and 1908 came from the western part of the State, and but 2 establishments in the eastern part of the State made coke in 1909.

There were altogether 6 coke-making establishments in Kentucky, but 2 of these were idle in 1909. The production increased from 37,827 short tons in 1908 to 46,371 tons in 1909. Most of this came from the western district. In this production 89,083 short tons of coal, all slack, was used, most of which was washed before being charged into the ovens.

The following table gives the statistics of production of coke in Kentucky in 1880, 1890, 1900, and for the last five years:

Statistics of the manufacture of coke in Kentucky, 1880–1909.

Year.	Establishments.	Ovens.		Coal used (short tons).	Coke produced (short tons).	Total value of coke at ovens.	Value of coke at ovens, per ton.	Yield of coal in coke (per cent).
		Built.	Building.					
1880	5	45	0	7,206	4,250	$12,250	$2.88	59.0
1890	9	175	103	24,372	12,343	22,191	1.80	51.0
1900	5	458	3	190,268	95,532	235,505	2.47	50.2
1905	6	495	0	154,783	79,487	159,659	2.01	51.4
1906	6	462	0	148,448	74,064	169,846	2.29	49.9
1907	6	495	0	129,538	67,068	157,288	2.35	51.7
1908	6	495	0	(a)	37,827	(a)	(a)	(a)
1909	6	494	0	89,083	46,371	101,257	2.18	52.0

a Included with other States having less than three producers.

MISSOURI.

Coke making in Missouri has never been an important industry, and, as in Kansas, has been limited to the coking of a small quantity of Pittsburg (Kansas) slack, the coke being used at the zinc smelters in connection with which the ovens were operated. One of the 2 small plants with which the State has been credited during the last five years was abandoned in 1907, and the other plant has been idle for the last 4 years.

The statistics of production for a series of years have been as follows:

Statistics of the manufacture of coke in Missouri, 1887–1909.

Year.	Establishments.	Ovens.		Coal used (short tons).	Coke produced (short tons).	Total value of coke at ovens.	Value of coke at ovens, per ton.	Yield of coal in coke (per cent).
		Built.	Building.					
1887	1	4	0	5,400	2,970	$10,395	$3.50	55.0
1890	3	10	0	9,491	6,136	9,240	1.51	65.0
1900	3	10	0	3,775	2,087	5,268	2.52	55.3
1905	2	6	0	2,551	1,580	4,072	2.58	61.9
1906	2	6	0	0	0	0	0	0
1907	1	5	0	0	0	0	0	0
1908	1	4	0	0	0	0	0	0
1909	1	4	0	0	0	0	0	0

MONTANA.

Of the 5 coke-making establishments in Montana, 3 were idle during 1909. The 2 plants operated were those of the Western Coal and Coke Company, at Lombard, and of the Montana Coal and Coke Company, at Electric. The 3 idle establishments had an aggregate of 300 ovens, and the 2 active, 251. All are of the beehive type. All of the coal used in the manufacture of coke in Montana is run-of-mine, some of which is crushed and washed before coking. In 1909 the unwashed coal used was 57,640 tons, and the washed coal 25,353 tons. The production of coke amounted to 37,069 short tons, indicating a yield per ton of coal in coke of 44.7. This was a decided decrease in the percentage yield from the three preceding years and was due to the larger proportion of the unwashed coal used in 1909.

In the following table are given the statistics of production of coke in Montana in 1884, when the first production was reported, and in 1890, 1900, and since 1905:

Statistics of the manufacture of coke in Montana, 1884–1909.

Year.	Establishments.	Ovens.		Coal used (short tons).	Coke produced (short tons).	Total value of coke at ovens.	Value of coke at ovens, per ton.	Yield o coal in coke (per cent).
		Built.	Building.					
1884	3	5	12	165	75	$900	$12.00	46.0
1890	2	140	0	32,148	14,427	125,655	8.71	45.0
1900	3	342	111	108,710	54,731	337,079	6.16	50.3
1905	4	555	100	68,777	31,482	211,351	6.71	45.8
1906	4	555	100	69,045	38,182	266,024	6.97	55.3
1907	5	567	15	68,948	40,714	295,174	7.25	59.0
1908	5	551	3	59,268	34,573	(a)	(a)	58.3
1909	5	551	3	82,993	37,069	(a)	(a)	44.7

a Included with other States having less than three producers.

NEW MEXICO.

The growing importance of New Mexico as a producer of coke has been exhibited in the statistics of the last four years, the production having increased from less than 90,000 tons in 1905 to 147,747 tons in 1906, to 265,125 tons in 1907, to 274,565 tons in 1908, and to 373,967 tons in 1909. It is to be noted that, notwithstanding the general decrease in coke production in 1908, that of New Mexico showed a gain. There are 4 establishments in the Territory, with a total of 1,030 ovens, 1 of the establishments of 50 ovens being idle in 1909. The new development in 1909 consisted of the enlargement of the Gardiner plant of the St. Louis, Rocky Mountain and Pacific Company from 186 to 200 ovens. There was no new construction under way at the close of the year. All of the coal used in the manufacture of coke in New Mexico is slack and all of it is from the Raton Mountain district. The total quantity used in 1909 was 694,390 short tons, valued at $650,876. Of this quantity, 182,583 tons were used unwashed and 511,807 tons were washed. All of the washed slack was used at the Dawson plant of the Stag Cañon Fuel Company. The coke produced amounted to 373,967 short tons, with a percentage yield of 53.9, and was valued at $1,099,694, or $2.94 per ton. The increase in 1909 over 1908 was 99,402 short tons, or 36.20 per cent in quantity, and $272,914, or 33.01 per cent in value.

The statistics of production in 1882, 1890, 1900, and from 1905 to 1909 are shown in the following table:

Statistics of the manufacture of coke in New Mexico, 1882–1909.

Year.	Establishments.	Ovens.		Coal used (short tons).	Coke produced (short tons).	Total value of coke at ovens.	Value of coke at ovens, per ton.	Yield of coal in coke (per cent).
		Built.	Building.					
1882	2	0	12	1,500	1,000	$6,000	$6.00	66.0
1890	2	70	0	3,980	2,050	10,025	4.89	51.5
1900	2	126	0	74,261	44,774	130,251	2.91	60.3
1905	3	258	498	148,469	89,638	253,229	2.83	60.4
1906	4	571	450	261,609	147,747	442,712	3.00	56.5
1907	4	896	125	446,140	265,125	840,253	3.17	59.4
1908	4	1,016	0	454,873	274,565	826,780	3.01	60.4
1909	4	1,030	0	694,390	373,967	1,099,694	2.94	53.9

OHIO.

Although Ohio ranks fourth among the coal-producing States, it is only within the last five years that it has assumed any importance in the manufacture of coke, and it still ranks only fifteenth in this respect. The reason for Ohio's backwardness in the manufacture of coke is that much of the coal mined in the State is a good blast-furnace fuel in its raw state and, on the other hand, it is not a strong coking coal. The progress made in the manufacture of coke since 1905 has been principally in the construction of by-product ovens, the coal for which is brought from West Virginia. The new work in 1909 consisted in the completion of an additional bank of 50 United-Otto ovens by the Hamilton Otto Coke Company, near Cincinnati, thus doubling its capacity. The Cleveland Furnace Company, at Cleveland, dismantled 80 of the 105 Rothberg ovens and began the construction of 49 Semet-Solvay ovens in place of the others, utilizing the old material from the Rothberg ovens. There are 7 coke-making establishments in the State, 6 of which made coke in 1909. The total number of ovens built decreased from 481 in 1908 to 447 in 1909, of which 26 were idle during the year. The only new construction under way on December 31 was the plant of 49 Semet-Solvay ovens at Cleveland. The total production in 1909 amounted to 222,711 short tons, valued at $683,155, an average of $3.07 per ton. The higher price of Ohio coke, as compared with that of Pennsylvania and West Virginia, is due to the fact that the coal used is obtained from the other States, and that the transportation charges have already been borne by the coal, as the coke is made near the points of consumption.

The statistics of the production of coke in Ohio in 1880, 1890, and 1900 and for the last five years are shown in the following table:

Statistics of the manufacture of coke in Ohio, 1880–1909.

Year.	Establishments.	Ovens.		Coal used (short tons).	Coke produced (short tons).	Total value of coke at ovens.	Value of coke at ovens, per ton.	Yield of coal in coke (per cent).
		Built.	Building.					
1880	15	616	25	172,453	100,596	$255,905	$2.54	58.0
1890	13	443	1	126,921	74,633	218,090	2.92	59.0
1900	8	369	50	115,269	72,116	194,042	2.69	62.5
1905	8	573	0	396,961	277,130	970,897	3.50	69.8
1906	8	575	0	437,567	293,994	1,013,248	3.45	67.2
1907	8	600	50	376,759	270,634	819,262	3.03	71.8
1908	7	481	50	237,448	159,578	491,982	3.08	67.2
1909	7	[a] 447	[b] 49	340,735	222,711	683,155	3.07	65.4

[a] Includes 25 Rothberg and 100 United-Otto ovens. [b] Semet-Solvay ovens.

The larger part of the coal used in coke making in Ohio is unwashed run-of-mine. In 1909 the coal charged into the ovens consisted of 293,554 tons of unwashed run-of-mine, 12,312 tons of unwashed slack, and 34,869 tons of washed slack.

The character of the coal used in the manufacture of coke in Ohio in 1890, 1900, and from 1905 to 1909 is shown in the following table:

Character of coal used in the manufacture of coke in Ohio since 1890, in short tons.

Year.	Run-of-mine.		Slack.		Total.
	Unwashed.	Washed.	Unwashed.	Washed.	
1890	34,729	0	54,473	37,719	126,921
1900	68,175	0	17,094	30,000	115,269
1905	348,502	0	10,837	37,622	396,961
1906	356,540	0	38,737	42,290	437,567
1907	268,637	45,712	36,514	25,896	376,759
1908	180,458	27,481	6,244	23,265	237,448
1909	293,554	0	12,312	34,869	340,735

OKLAHOMA.

Attempts to manufacture coke out of Oklahoma coal do not appear to have met with success. There are 5 establishments in the State, with a total of 536 ovens, 50 of which were completed in 1909, but no coke was produced on a commercial scale at any of these plants during that year. In 1905 the coke made in Indian Territory amounted to 54,781 short tons, since which time the production has decreased each year until it ceased altogether in 1909.

The following table gives the statistics of the manufacture of coke in Oklahoma (Indian Territory) in 1880, 1890, 1900, and from 1905 to 1909:

Statistics of the manufacture of coke in Oklahoma (Indian Territory), 1880–1909.

Year.	Establishments.	Ovens.		Coal used (short tons).	Coke produced (short tons).	Total value of coke at ovens.	Value of coke at ovens, per ton.	Yield of coal in coke (per cent).
		Built.	Building.					
1880	1	20	0	2,494	1,546	$4,638	$3.00	62.0
1890	1	80	0	13,278	6,639	21,577	3.25	50.0
1900	3	230	0	79,534	38,141	152,204	3.99	48.0
1905	5	388	50	123,389	54,781	199,424	3.64	44.4
1906	5	490	0	95,296	49,782	204,205	4.10	52.2
1907	5	490	50	38,615	19,089	82,447	4.32	49.4
1908	5	486	50	(a)	2,944	(a)	(a)	(a)
1909	5	536	0	0	0	0	0	0

a Included with other States having less than three producers.

PENNSYLVANIA.

Relatively speaking, Pennsylvania ranks higher in the manufacture of coke than in the mining of coal. The State stands well in the front in both regards, but for the last few years in the combined output of anthracite and bituminous coal Pennsylvania has produced a little less than half of the total output of coal in the United States, whereas in the production of coke Pennsylvania continues to furnish more than 60 per cent of the total. The two principal coal-producing counties of Pennsylvania, Fayette and Westmoreland, in which the Connellsville and the Lower Connellsville coking districts are located, contribute more than 10 per cent of the total coal production of the United States and nearly 50 per cent of the entire production of coke. The Connellsville district proper includes portions of both counties. The Lower Connellsville district is located entirely in Fayette County and is separated from the main Connellsville district by the Greensburg anticline. It was opened in 1900, and although now only 10 years of age it is the second coke-producing district in the United States. The Upper Connellsville, or Latrobe, district is the northern extremity of the Connellsville Basin. The combined production of the three districts represents 75 per cent of the total production of the State.

The quantity of coke produced in Pennsylvania in 1909 was 24,905,525 short tons, out of a total for the United States of 39,315,065 short tons. In 1908 Pennsylvania produced 15,511,634 short tons, out of a total of 26,033,518 tons. The increase in 1909 over 1908 was 9,393,891 short tons, or a little more than 60 per cent. Notwithstanding this large increase, the production in 1909 was 1,607,689 short tons less than the output recorded in 1907, when the maximum of 26,513,214 tons was obtained.

The total value of the coke production in Pennsylvania in 1909 was $50,377,035, against $32,569,621 in 1908 and $67,638,024 in 1907. The increase in 1909 over 1908 was $17,807,414, or a little less than 55 per cent, as compared with an increase of more than 60 per cent in quantity. Compared with 1907 the value of the product in 1909 shows a decrease of $17,260,989.

The average price per ton obtained for coke in Pennsylvania in 1909 was $2.02, against $2.10 in 1908 and $2.55 in 1907. The average for 1909 was the lowest in five years. During the first six months of 1909 the coking industry was in a demoralized condition, not having recovered from the effects of the business depression of 1908. Production was in excess of demand and prices were at their lowest ebb, notwithstanding an agreement among Connellsville coke makers not to sell their product below a certain figure. Business revived about the middle of the year, and on account of a shortage of labor at the mines and ovens the demand in the last six months caught up with and exceeded the output, so that in November and December spot coke that was not subject to contract prices sold nearly as high as in the boom periods of 1906 and 1907. This improvement was not, however, sufficient entirely to overcome the effect of the low prices in the first half of the year.

The quantity of coal consumed in the manufacture of coke in Pennsylvania in 1909 was 36,983,568 short tons, equal to 26.8 per cent of the total bituminous coal production of the State. Of the State's total production of bituminous coal, 23,215,964 tons, or 19.8 per cent, were used in 1908 in coke making. The value of the coal used in 1909 was $32,065,729 and the value of the coke produced was $50,377,035, the difference in the values of the coal and coke being $18,311,306, or 57.1 per cent. That the depressed condition of business in 1908 was looked upon as only a temporary setback is exhibited in the statistics of new construction in the coking districts of Pennsylvania. There was an addition of 31 in the coking establishments of the State, from 252 in 1908 to 283 in 1909. Thirteen of the new establishments were in the Connellsville district, 8 were in the Lower Connellsville district, and 7 in the Allegheny Mountain district. The total number of completed ovens increased from 52,606 in 1908 to 54,506 in 1909, a gain of 1,900. There were 2,072 new ovens building at the close of the year. Of the new ovens added, 914 were of a recently developed type of longitudinal or rectangular construction which has met with some favor, particularly in the Lower Connellsville district. They differ from the beehive oven only in the shape of the oven and not in the process of carbonization of the coal. Of the 2,072 ovens building at the close of the year, 746 were of the longitudinal or rectangular design. The completed ovens include also 936 United-Otto and 360 Semet-Solvay by-product recovery ovens. None of the ovens under construction at the end of the year were of the by-product recovery type.

The statistics of the production of coke in Pennsylvania for the years 1880, 1890, 1900, and for the last five years are shown in the following table:

Statistics of the manufacture of coke in Pennsylvania, 1880–1909.

Year.	Establishments.	Ovens.		Coal used (short tons).	Coke produced (short tons).	Total value of coke at ovens.	Value of coke at ovens, per ton.	Yield of coal in coke (per cent).
		Built.	Building.					
1880	124	9,501	836	4,347,558	2,821,384	$5,255,040	$1.86	65.0
1890	106	23,430	74	13,046,143	8,560,245	16,333,674	1.91	65.6
1900	177	32,548	2,310	20,239,966	13,357,295	29,692,258	2.22	66.0
1905	226	42,608	2,384	31,030,345	20,573,736	42,253,178	2.05	66.3
1906	239	47,185	2,373	34,503,513	23,060,511	54,184,531	2.35	66.8
1907	253	51,364	1,337	39,733,177	26,513,214	67,638,024	2.55	66.7
1908	252	52,606	1,720	23,215,964	15,511,634	32,569,621	2.10	66.8
1909	283	[a]54,506	[b]2,072	36,983,568	24,905,525	50,377,035	2.02	67.3

[a] Includes 936 United-Otto, 360 Semet-Solvay, 152 Newton-Chambers, 864 rectangular, 50 longitudinal, and 236 Mitchell ovens.
[b] Includes 686 rectangular and 60 Belgian ovens.

By far the larger part of the coal used in coke making in Pennsylvania is unwashed run of mine. The coal mined in the Connellsville districts is an ideal coking coal and requires no preparation for the coke oven, though some of it is crushed before being charged. Of the 36,983,568 short tons of coal used in 1909 for coke making in Pennsylvania, 31,712,482 tons were unwashed mine run and 1,016,576 tons were unwashed slack. The washed coal used consisted of 2,278,927 tons of mine run and 1,975,583 tons of slack.

The character of the coal used in the manufacture of coke in Pennsylvania in 1890, 1895, 1900, and from 1905 to 1909 has been as follows:

Character of coal used in the manufacture of coke in Pennsylvania since 1890, in short tons.

Year.	Run of mine.		Slack.		Total.
	Unwashed.	Washed.	Unwashed.	Washed.	
1890	11,788,625	303,591	630,195	323,732	13,046,143
1895	13,618,376	34,728	440,869	117,594	14,211,567
1900	17,692,623	647,045	1,300,796	599,502	20,239,966
1905	26,148,696	1,335,631	2,436,621	1,109,397	31,030,345
1906	27,471,566	3,972,712	1,584,152	1,475,083	34,503,513
1907	33,589,751	2,267,142	2,566,090	1,310,194	39,733,177
1908	18,691,073	1,718,944	1,062,478	1,743,469	23,215,964
1909	31,712,482	2,278,927	1,016,576	1,975,583	36,983,568

PRODUCTION BY DISTRICTS.

In previous chapters of this series of reports it has been customary to consider the production of coke in Pennsylvania according to certain well-defined districts. These divisions are based to some extent upon geographic boundaries, but also upon the quality of the coal mined and the coke produced. Each district has been more fully described in some of the preceding volumes, but the following brief statement regarding the territory included in the different coking districts is repeated here for the sake of convenience.

The Allegheny Mountain district includes the ovens along the line of the Pennsylvania Railroad from Gallitzin eastward over the crest of the Alleghenies to a point beyond Altoona. The Allegheny Valley district formerly included the coke works of Armstrong and Butler counties and one of those in Clarion County, the other ovens in the latter county being included in the Reynoldsville-Walston district. All but two of the Allegheny Valley plants have been abandoned, and the production previous to 1908 has been included in that of the Pittsburg district. During 1909 the plants were idle throughout the year. What was previously known as the Beaver district included the ovens in Beaver and Mercer counties, but all the ovens in Beaver County have been abandoned, those formerly operated by the Semet-Solvay Company in Mercer County have been abandoned, and the operations of the one establishment of United-Otto ovens at South Sharon are now also included in the Pittsburg district. The Blossburg and the Broadtop districts embrace the Blossburg and the Broadtop coal fields. The ovens of the Clearfield-Center district are chiefly in the two counties from which it derives its name. A few ovens constructed recently in Elk County have been included in the Clearfield-Center district. The Connellsville district is the well-known region of western Pennsylvania in Westmoreland and Fayette counties, extending from just south of Latrobe to Fairchance. The Lower Connellsville region is entirely in Fayette County and southwest of the Connellsville Basin proper, from which it is separated by the Greensburg anticline. It embraces the recent developments in the vicinity of Uniontown and is now the second producing district of the State. The Greensburg, Irwin, Pittsburg, and Reynoldsville-Walston districts include the ovens near the towns which have given the names to these districts. The Upper Connellsville district, sometimes called the Latrobe district, is near the town of Latrobe. The Semet-Solvay ovens at Chester, Steelton, and Lebanon, and the United-Otto ovens at Lebanon are in what has been designated as the Lebanon-Schuylkill district, the production of which has previously been combined with that of the Broadtop district. Owing to the number of establishments being less than three in several of the districts during 1909 the only ones for which separate statistics are published are: Allegheny Mountain, Connellsville, Greensburg, Lower Connellsville, Pittsburg, Reynoldsville-Walston, and Upper Connellsville districts.

The statistics of the manufacture of coke in Pennsylvania, by districts, in 1908 and 1909, are presented in the following tables:

Coke production in Pennsylvania in 1908 and 1909, by districts.

1908.

District.	Establishments.	Ovens.		Coal used (short tons).	Coke produced (short tons).	Total value of coke at ovens.	Value of coke per ton.	Yield of coal in coke (per cent).
		Built.	Building.					
Allegheny Mountain	16	a 2,394	99	1,208,221	859,648	$2,055,779	$2.39	71.1
Broadtop	6	680	30	198,798	125,722	235,382	1.87	63.2
Connellsville	104	b 24,071	118	10,238,665	6,880,951	14,025,422	2.04	67.2
Greensburg	7	1,690	60	1,119,391	694,032	1,489,303	2.15	62.0
Lower Connellsville	62	c 13,162	d 1,203	6,156,553	4,252,222	7,796,860	1.83	69.1
Pittsburg	9	e 3,110	150	1,742,119	1,103,413	2,592,403	2.35	63.3
Reynoldsville - Walston	9	2,781	0	1,198,938	655,312	1,649,541	2.50	54.7
Upper Connellsville	22	2,906	60	779,468	514,525	897,631	1.74	66.0
Other districts f	17	g 1,812	0	573,811	425,809	1,827,300	4.29	74.0
Total	252	52,606	1,720	23,215,964	15,511,634	32,569,621	2.10	66.8

1909.

District.	Establishments.	Ovens.		Coal used (short tons).	Coke produced (short tons).	Total value of coke at ovens.	Value of coke per ton.	Yield of coal in coke (per cent).
		Built.	Building.					
Allegheny Mountain	23	a 2,581	0	1,619,634	1,156,554	$2,327,353	$2.01	71.4
Allegheny Valley	2	52	0	0	0	0	....	....
Connellsville	117	b 24,422	h 370	17,581,899	11,769,758	23,379,149	1.99	66.9
Greensburg	7	1,751	i 246	1,443,394	926,568	1,816,029	1.97	64.2
Lower Connellsville	70	j 14,215	k 1,036	9,781,803	6,761,335	12,490,518	1.85	69.1
Pittsburg	11	e 3,299	420	2,826,164	1,757,338	4,444,243	2.53	62.2
Reynoldsville - Walston	9	2,781	0	1,151,530	702,136	1,587,385	2.26	61.0
Upper Connellsville	22	l 2,915	0	1,282,756	863,769	1,525,011	1.77	67.3
Other districts m	22	n 2,490	0	1,296,388	968,067	2,807,347	2.90	74 7
Total	283	54,506	2,072	36,983,568	24,905,525	50,377,035	2.02	67.3

a Includes 372 United-Otto and 152 Newton-Chambers ovens.
b Includes 110 Semet-Solvay ovens.
c Includes 149 rectangular ovens.
d Includes 249 rectangular ovens.
e Includes 330 United-Otto and 10 rectangular ovens.
f Includes Allegheny Valley, Clearfield-Center, Irwin, and Lebanon and Schuylkill valleys districts.
g Includes 232 United-Otto and 250 Semet-Solvay ovens.
h Includes 100 rectangular ovens.
i Includes 60 rectangular ovens.
j Includes 775 rectangular ovens.
k Includes 586 rectangular ovens.
l Includes 79 rectangular ovens.
m Includes Broadtop, Clearfield-Center, Irwin, and Lebanon and Schuylkill valleys districts.
n Includes 250 Semet-Solvay and 232 United-Otto ovens.

Connellsville district.—The Connellsville district of Pennsylvania is the largest coke-producing district in the world. The coal basin occupies a comparatively narrow synclinal trough, extending in a northeast-southwest direction nearly across the two counties of Fayette and Westmoreland and lying entirely within their boundaries. It is a short distance east of the city of Pittsburg and supplies the larger part of the fuel consumed in the iron and steel furnaces of Pittsburg and vicinity, the greatest iron-manufacturing center of the world. Large quantities of Connellsville coke are also shipped to distant points of consumption. This district, until 1903, produced from 40 to 50 per cent of the total coke output of the United States, the smaller percentage during the last few years being due to the largely increased production from the Lower Connellsville or Klondike region, which lies entirely within Fayette County and is separated from the Connellsville Basin proper by the Greensburg anticline. If to the Connellsville production is added that of the Lower Connellsville district, the supremacy of the region was more than maintained in 1909.

Connellsville coal is the ideal fuel for coking in beehive ovens, and it is probably to the success of the beehive practice in the Connellsville district that is due the prevalence of the beehive oven in coke manufacturing in the United States, manufacturers being led by the idea that because beehive coke manufactured from Connellsville coal is the standard for furnace and foundry use, other coal should also be coked in beehive ovens, whereas many coals are found to give more satisfactory results in retort ovens. Connellsville coke is considered by some ironmasters as without rival for blast-furnace use, and it is undoubtedly the standard by which all other blast-furnace cokes in the United States are judged.

At the close of 1909 there were 24,422 completed ovens in the Connellsville district with 370 building, against 24,071 ovens built and 118 under construction on December 31, 1908. All of the completed ovens are of the beehive type, except 110 Semet-Solvay by-product ovens and 50 Mitchell ovens. The new ovens building at the close of the year include 100 rectangular ovens, but no retort ovens. The number of coke-making establishments in the district increased from 104 in 1908 to 117 in 1909. Of the 117 establishments, 7 with a total of 393 ovens were idle throughout the year. The number of ovens in blast the whole or a part of the year was 24,029; the average production per active oven was 489.8 tons.

In no part of the country was the depression in the iron trade of 1908 more significantly illustrated than in the Connellsville coking district. The output of this district decreased from 13,089,427 tons in 1907 to 6,880,951 tons in 1908, a difference of 6,208,476 tons, or 47.4 per cent, with a somewhat larger decline in value. The recovery in 1909 did not make itself felt in the Connellsville district until quite late in the summer, by which time deliveries of coke for the latter part of the year had been contracted for at the low prices of the first six months, and only coke uncontracted for got the benefit of the advances. The average price obtained for Connellsville coke in 1909 was $1.99, though, as may be seen from the table of prices on a succeeding page, furnace coke sold for as high as $3 and foundry coke for $3.50 before the end of the year.

In the following table are presented the statistics of the manufacture of coke in the Connellsville district in 1880, 1890, 1900, and from 1905 to 1909:

Statistics of the manufacture of coke in the Connellsville region, Pennsylvania, 1880–1909.

Year.	Establishments.	Ovens.		Coal used (short tons).	Coke produced (short tons).	Total value of coke at ovens.	Value of coke at ovens, per ton.	Yield of coal in coke (per cent).
		Built.	Building.					
1880	67	7,211	731	3,367,856	2,205,946	$3,948,643	$1.79	65.5
1890	28	15,865	30	9,748,449	6,464,156	11,537,370	1.94	66.3
1900	98	20,981	686	14,946,659	10,020,907	22,383,432	2.23	67.0
1905	100	22,033	200	16,980,341	11,365,077	22,315,361	1.96	66.9
1906	101	23,616	142	17,956,160	12,057,840	26,858,660	2.23	67.1
1907	101	23,857	0	19,751,739	13,089,427	30,355,050	2.32	66.3
1908	104	24,071	118	10,238,665	6,880,951	14,025,422	2.04	67.2
1909	117	[a]24,422	[b]370	17,581,899	11,769,758	23,379,149	1.99	66.9

[a] Includes 110 Semet-Solvay by-product ovens. [b] Includes 100 rectangular ovens.

The following table, compiled by the Connellsville Courier, of Connellsville, Pa., shows the shipments of coke, by months, from the Connellsville region in 1908 and 1909. The figures are given in cars and tons with the average number of cars shipped each working day in the month, and include the shipments from both the Upper and the Lower Connellsville districts as well as the Connellsville district proper. This authority gives the shipments in 1909 at 17,785,832 tons, whereas the production as reported to the Survey was 19,394,862 tons.

Shipments of coke from the Connellsville region, including Upper and Lower Connellsville districts, in 1908 and 1909, by months.

Month.	1908.			1909.		
	Cars.	Daily average.	Short tons.	Cars.	Daily average.	Short tons.
January	25,632	949	742,096	40,782	1,568	1,205,650
February	27,041	1,081	810,436	38,419	1,600	1,143,487
March	28,664	1,102	841,059	39,934	1,479	1,185,814
April	26,314	1,012	772,915	38,574	1,483	1,144,751
May	25,567	948	759,813	41,294	1,588	1,235,044
June	26,904	1,034	772,367	48,067	1,849	1,429,289
July	30,066	1,113	856,843	54,635	2,023	1,605,937
August	32,938	1,266	952,492	55,724	2,143	1,641,287
September	33,646	1,294	975,606	58,247	2,240	1,704,919
October	35,252	1,305	1,030,552	61,440	2,363	1,821,444
November	34,665	1,386	995,807	61,813	2,377	1,835,745
December	41,533	1,597	1,190,036	62,050	2,298	1,832,465
Total	368,222	1,173	10,700,022	600,979	1,920	17,785,832

The monthly shipments from this region in the years 1905 to 1909, as reported by the Courier, are given in the following table:

Monthly shipments of coke from the Connellsville region, 1905–1909, in short tons.

Month.	1905.	1906.	1907.	1908.	1909.
January	1,283,152	1,665,747	1,698,475	742,096	1,205,650
February	1,350,128	1,435,452	1,625,783	810,436	1,143,487
March	1,497,756	1,683,212	1,701,342	841,059	1,185,814
April	1,843,502	1,604,906	1,708,590	772,915	1,144,751
May	1,451,554	1,739,743	1,787,611	759,813	1,235,044
June	1,354,470	1,654,209	1,677,488	772,367	1,429,289
July	1,622,998	1,662,545	1,741,612	856,843	1,605,937
August	1,328,002	1,685,086	1,787,190	952,492	1,641,287
September	1,726,734	1,610,509	1,650,207	975,606	1,704,919
October	1,430,238	1,850,450	1,805,307	1,030,552	1,821,444
November	1,488,942	1,752,234	1,167,796	995,807	1,835,745
December	1,519,050	1,655,283	677,657	1,190,036	1,832,465
Total	17,896,526	19,999,326	19,029,058	10,700,022	17,785,832

The total shipments, in cars, for the last twenty-two years were as follows:

Total and daily average shipments, in cars, 1888–1909.

Year.	Daily average.	Total cars.	Year.	Daily average.	Total cars.	Year.	Daily average.	Total cars.
1888	905	282,441	1896	920	289,137	1904	1,623	510,759
1889	1,046	326,220	1897	1,181	367,383	1905	1,886	688,328
1890	1,147	355,070	1898	1,415	441,249	1906	2,385	745,274
1891	884	274,000	1899	1,676	523,203	1907	2,210	691,757
1892	1,106	347,012	1900	1,619	504,410	1908	1,173	368,222
1893	874	270,930	1901	1,857	581,051	1909	1,920	600,979
1894	900	281,677	1902	1,986	624,198			
1895	1,410	441,243	1903	1,782	558,738			

As Connellsville coke is recognized as the standard for the United States and governs largely the prices for the product of other districts, the following table is given showing the prices for furnace and foundry coke, by months, during the years 1905 to 1909. These prices are quoted from The Iron Age, and are for strict Connellsville coke. "Main Line" and "outside" cokes are usually quoted from 15 to 20 cents below the strict Connellsville. The higher ranges during the first six months of the year were the result of a combination among the independent producers in the Connellsville region to maintain prices in spite of overproduction and slack demand. The effect of the revival in the latter half of 1909 is exceptionally well shown in this table, which shows that Connellsville furnace coke sold as low as $1.50 in the first half of the year and reached as high as $3 in the last half. Foundry coke, which sold as low as $1.75 in April, brought $3.50 in October, November, and December. The average price for Connellsville coke, as shown by actual sales and amounts received therefor was $1.99, indicating that considerable deliveries of coke were made in the latter part of the year at the lower contract prices of 1908 and of the first six months of 1909.

Prices of Connellsville furnace and foundry coke, 1905-1909, by months.

Month.	Furnace.				
	1905.	1906.	1907.	1908.	1909.
January	$2.10 to $3.00	$2.15 to $2.75	$3.50 to $3.75	$1.90 to $2.25	$1.50 to $2.00
February	2.00 to 2.75	2.10 to 2.50	3.50 to 3.65	1.70 to 2.25	1.50 to 1.65
March	2.25 to 2.50	2.20 to 2.50	2.90 to 3.25	1.80 to 1.85	1.55 to 2.00
April	1.90 to 2.25	2.30 to 2.75	2.65 to 2.85	1.50 to 1.60	1.60 to 1.85
May	1.80 to 2.00	2.30 to 2.75	2.00 to 2.85	1.50 to 1.60	1.50 to 1.90
June	1.75 to 2.10	2.30 to 2.50	1.75 to 2.65	1.50 to 1.60	1.50 to 1.75
July	1.75 to 2.10	2.40 to 2.75	2.40 to 2.60	1.50 to 1.60	1.60 to 1.80
August	1.80 to 2.10	2.75 to 2.85	2.40 to 2.85	1.50 to 1.55	1.65 to 2.00
September	1.90 to 2.50	2.85 to 2.90	2.75 to 2.90	1.50 to 1.55	2.00 to 3.00
October	2.35 to 3.10	2.75 to 3.25	2.75 to 3.00	1.50 to 1.65	2.75 to 3.00
November	2.85 to 3.00	3.00 to 3.60	2.00 to 2.75	1.65 to 1.85	2.75 to 2.90
December	2.75 to 2.90	3.00 to 3.60	2.00 to 2.50	1.75 to 1.90	2.60 to 2.90

Month.	Foundry.				
	1905.	1906.	1907.	1908.	1909.
January	$2.25 to $2.75	$2.75 to $3.50	$4.00 to $4.50	$2.00 to $2.65	$2.00 to $2.50
February	2.50 to 3.00	2.50 to 3.00	3.75 to 4.50	2.40 to 2.75	1.85 to 2.25
March	2.75 to 3.25	2.75 to 3.25	3.50 to 4.00	2.10 to 2.40	1.85 to 2.25
April	2.65 to 3.00	2.90 to 3.10	3.25 to 3.75	1.85 to 2.25	1.75 to 2.40
May	2.50 to 2.75	2.65 to 3.10	2.75 to 3.25	2.00 to 2.25	1.80 to 2.35
June	2.35 to 2.65	2.65 to 2.75	3.00 to 3.25	2.00 to 2.25	1.80 to 2.50
July	2.25 to 2.50	2.75 to 3.00	3.00 to 3.25	2.00 to 2.25	1.80 to 2.50
August	2.25 to 2.50	3.00 to 3.25	3.00 to 3.75	1.90 to 2.25	1.70 to 2.50
September	2.40 to 3.00	3.25 to 3.50	3.15 to 3.50	1.90 to 2.00	2.25 to 3.25
October	2.75 to 3.50	3.25 to 4.00	3.25 to 3.40	2.00 to 2.25	2.75 to 3.50
November	3.50 to 4.00	3.75 to 4.50	2.50 to 3.00	2.15 to 2.25	3.00 to 3.50
December	3.40 to 4.00	3.75 to 4.50	2.50 to 2.75	2.15 to 2.25	3.25 to 3.50

Lower Connellsville district.—This district, which is now the second coke-making district in the United States, was opened in 1900, and was, accordingly, at the close of 1909 only 10 years old. The production of this district in 1900 was 385,909 short tons; in 1909 it was 6,761,335 tons, equivalent to more than 50 per cent of the quantity produced in the Connellsville district proper. The production of the

Lower Connellsville district in 1909 was nearly three times as large as that of the Pocahontas or Flat Top district in West Virginia, which, until 1902, was the second coke-producing region in the United States, and more than the entire output of West Virginia, which ranks second among the States in coke production. In two respects the production of coke in the Lower Connellsville district in 1909 was exceptional. It exceeded the previous high record of 1907, and it also brought a higher average price than the production of 1908. The total production of the district increased from 4,252,222 short tons, valued at $7,796,860, in 1908, to 6,761,335 short tons, valued at $12,490,518, in 1909, an increase of 59 per cent in production and of 60.2 per cent in value. The total number of establishments in the district increased from 62 in 1908 to 70 in 1909, and the number of completed ovens from 13,162 to 14,215. The completed ovens include 775 rectangular or longitudinal ovens, which seem to have met with considerable favor in this district, and most of which were completed in 1909. There were 1,036 new ovens under construction on December 31, and of the new ovens 586 were of the rectangular or longitudinal type. Of the 70 establishments in 1909, all but 2, with a total of 130 ovens, made coke during 1909. The average production for the 14,085 active ovens in 1909 was 480 tons of coke.

The record of the district in 1900, and from 1905 to 1909, has been as follows:

Statistics of the manufacture of coke in the Lower Connellsville district, Pennsylvania, 1900, and 1905–1909.

Year.	Establishments.	Ovens.		Coal used (short tons).	Coke produced (short tons).	Total value of coke at ovens.	Value of coke at ovens, per ton.	Yield of coal in coke (per cent).
		Built.	Building.					
1900	12	2,033	1,112	579,928	385,909	$792,886	$2.05	66.5
1905	45	7,484	1,145	5,666,812	3,871,310	7,532,382	1.95	68.3
1906	53	9,708	1,502	7,465,205	5,188,135	12,046,889	2.32	69.4
1907	62	12,264	1,068	9,150,693	6,310,900	15,758,049	2.50	69.0
1908	62	13,162	1,203	6,156,553	4,252,222	7,796,860	1.83	69.1
1909	70	a14,215	b1,036	9,781,803	6,761,335	12,490,518	1.85	69.1

a Includes 775 rectangular ovens. b Includes 586 rectangular ovens.

TENNESSEE.

Although the production of coke in Tennessee in 1909 exceeded that of 1908, it was less than in any other preceding year since 1885, a period of twenty-five years. Compared with 1908, there was a decrease of 1 in the number of coke-making establishments, and of 63 in the number of ovens, the latter having decreased from 2,792 in 1908 to 2,729 in 1909. There was a larger percentage of idle ovens in Tennessee than in any other eastern coke-producing State, 1,178 out of 2,729 ovens not having been operated during 1909. There was no new construction in progress at the close of the year. The total production increased from 214,528 short tons, valued at $561,789, in 1908 to 261,808 short tons, valued at $667,723, in 1909, a gain of 47,280 tons, or 22.04 per cent, in quantity, and of $105,934, or 18.86 per cent, in value, whereas the average percentage of increase for the United States was 51.02 as to production and 43.92 as to value.

The statistics of the manufacture of coke in Tennessee in the years 1880, 1890, 1900, and from 1905 to 1909 are shown in the following table:

Statistics of the manufacture of coke in Tennessee, 1880–1909.

Year.	Establishments.	Ovens.		Coal used (short tons).	Coke produced (short tons).	Total value of coke at ovens.	Value of coke at ovens, per ton.	Yield of coal in coke (per cent).
		Built.	Building.					
1880	6	656	68	217,656	130,609	$316,607	$2.42	60.0
1890	11	1,664	292	600,387	348,728	684,116	1.96	58.0
1900	14	2,107	340	854,789	475,432	1,269,555	2.67	55.6
1905	16	2,615	60	862,320	468,092	1,184,442	2.53	54.3
1906	17	2,731	138	929,405	483,428	1,350,856	2.79	52.0
1907	18	2,806	80	825,221	467,499	1,592,225	3.41	56.6
1908	17	2,792	20	395,936	214,528	561,789	2.62	54.2
1909	16	2,729	0	493,283	261,808	667,723	2.55	53.1

There were 493,283 tons of coal used in the manufacture of coke in Tennessee in 1909, of which 30,361 were unwashed and 462,922 were washed.

The character of the coal used in the manufacture of coke in Tennessee in 1890, 1900, and since 1905, is shown in the following table:

Character of coal used in the manufacture of coke in Tennessee, 1890, 1900, and 1905–1909, in short tons.

Year.	Run-of-mine.		Slack.		Total.
	Unwashed.	Washed.	Unwashed.	Washed.	
1890	255,359	0	273,028	72,000	600,387
1900	150,697	349,448	24,122	330,522	854,789
1905	134,432	244,302	46,073	437,513	862,320
1906	81,825	509,532	142,843	195,205	929,405
1907	54,397	386,094	0	384,730	825,221
1908	29,668	250,120	102,578	13,570	395,936
1909	30,361	285,591	0	177,331	493,283

UTAH.

As there is but one company in Utah engaged in the manufacture of coke, the statistics of production have been included with those of Colorado, which adjoins Utah on the east. The coals of Utah used in the manufacture of coke are practically identical in character with those of western Colorado.

VIRGINIA.

All the coking coals of Virginia are contained in a few counties lying in the extreme southwestern portion of the State and within the coal fields of the Appalachian province. The development of this region began in 1883 with the completion of the New River division of the Norfolk and Western Railway, and for ten years the manufacture of coke, as well as the production of coal in Virginia, was almost entirely from Tazewell County. Ten years from the opening of the district, or in 1893, the Norfolk and Western Railway completed a branch up the Clinch Valley and opened what is now the most important coking-coal district in Wise County. During 1906 and 1907 extensive developments in what is known as the Black Mountain field in Lee County followed the construction into that district of the Black Mountain Railroad, now operated jointly by the Southern Railway and the Louisville and Nashville Railroad. The first ovens in Lee County were reported as under construction in 1907, and an output of something over 50,000 tons was reported at Keokee in that county in 1908. In 1909 the production of this district increased to over 100,000 tons. The total production for the State increased from 1,162,051 short tons in 1908 to 1,347,478 tons in 1909, a gain of 185,427 tons, or 15.96 per cent. The value increased from $2,121,980 in 1908 to $2,415,769 in 1909, a gain of $293,789, or 13.85 per cent. The average price per ton decreased from $1.83 to $1.79. The number of establishments was the same in 1909 as in 1908 and 1907. The total number of ovens increased from 4,853 in 1908 to 5,469 in 1909, and there were 100 ovens building at the close of the latter year. Of the 5,469 ovens in the State, only 78 were idle during 1909, and 56 of these were the Newton-Chambers ovens at Pocahontas, which have not been in practical operation since they were first installed. The coke manufactured in Wise County, on the Clinch Valley branch of the Norfolk and Western Railway, and in the Black Mountain district in Lee County is the only coke made in Virginia from coal mined exclusively within the State. There are two plants in Virginia, one at Lowmoor and one at Covington, the coal for both of which is drawn from the mines in the New River district of West Virginia. The coal for the ovens at Pocahontas in Tazewell County is obtained from mines whose workings extend across the state boundary line into West Virginia and a part of this coal production should properly be credited to West Virginia. The openings of the mines, however, and the coke evens, are in Tazewell County, and it is customary to credit the coal, as well as the coke, to Virginia.

The statistics of the manufacture of coke in Virginia in 1883, when the first operations were begun, and in 1890, 1900, and from 1905 to 1909, inclusive, are shown in the following table:

Statistics of the manufacture of coke in Virginia, 1883–1909.

Year.	Establishments.	Ovens.		Coal used (short tons).	Coke produced (short tons).	Total value of coke at ovens.	Value of coke at ovens, per ton.	Yield of coal in coke (per cent).
		Built.	Building.					
1883	1	200	0	39,000	25,340	$44,345	$1.75	65.0
1890	2	550	250	251,683	165,847	278,724	1.68	66.0
1900	7	2,331	300	1,083,827	685,156	1,464,556	2.14	63.2
1905	16	4,549	0	2,184,369	1,499,481	2,869,452	1.91	68.6
1906	18	4,641	695	2,296,227	1,577,659	3,611,659	2.29	68.7
1907	19	5,333	50	2,264,720	1,545,280	3,765,733	2.44	68.2
1908	19	4,853	158	1,785,281	1,162,051	2,121,980	1.83	65.1
1909	19	[a] 5,469	100	2,060,518	1,347,478	2,415,769	1.79	65.4

[a] Includes 56 Newton-Chambers ovens.

All of the coal used in the manufacture of coke in Virginia in 1907, 1908, and 1909 was unwashed. In 1909, out of a total of 2,060,518 tons used in coking, 1,405,111 tons were run-of-mine, and 655,407 tons were slack.

The table following shows the character of the coal used in coke making in Virginia in 1890, 1900, and from 1905 to 1909.

Character of coal used in the manufacture of coke in Virginia, 1890–1909, in short tons.

Year.	Run-of-mine.		Slack.		Total.
	Unwashed.	Washed.	Unwashed.	Washed.	
1890	98,215	0	153,468	0	251,683
1900	620,207	0	463,620	0	1,083,827
1905	1,096,656	0	1,087,713	0	2,184,369
1906	1,014,299	228,347	1,053,581	0	2,296,227
1907	1,271,518	0	993,202	0	2,264,720
1908	1,438,754	0	346,527	0	1,785,281
1909	1,405,111	0	655,407	0	2,060,518

WASHINGTON.

Of the 6 coke-making establishments in Washington, 3, with a total of 185 ovens, made coke in 1909, and 3, with a total of 100 ovens, were idle. The total production amounted to 42,981 short tons, valued at $240,604, an increase of 4,092 tons, or 10.52 per cent, and of $27,466, or 12.89 per cent, over 1908, when the production amounted to 38,889 tons, valued at $213,138. Washington is the only State west of the Rocky Mountains in which coking coals occur. The industry is not a large one when compared with the operations in some of the Eastern States, but is of interest as showing the availability of smelter and blast-furnace fuel for such industries in the Pacific coast States. All of the coking operations at present are in Pierce County, in the central part of the State, but recent tests made at the United States Geological Survey plant at Denver established the coking qualities of coal from the northern part of the Roslyn field, in Kittitas County. It is reported that the construction of a plant of United-Otto by-product ovens is in contemplation at South Seattle, but there were no new ovens of any type under construction at the close of 1909.

The coke-making industry of Washington began in 1884, when 400 tons of coke were produced. The record since that time has been as follows:

Statistics of the manufacture of coke in Washington, 1884–1909.

Year.	Establishments.	Ovens.		Coal used (short tons).	Coke produced (short tons).	Total value of coke at ovens.	Value of coke at ovens, per ton.	Yield of coal in coke (per cent).
		Built.	Building.					
1884	1	0	0	700	400	$1,900	$4.75	57.0
1890	2	30	80	9,120	5,837	46,696	8.00	64.0
1900	2	90	0	54,310	33,387	160,165	4.80	61.5
1905	5	216	0	85,715	53,137	251,717	4.74	62.0
1906	5	216	0	76,896	45,642	226,977	4.99	59.4
1907	5	216	0	85,860	52,028	293,019	5.63	60.6
1908	6	231	50	68,069	38,889	213,138	5.48	57.1
1909	6	285	0	69,708	42,981	240,604	5.60	61.7

WEST VIRGINIA.

West Virginia ranks second among the States in the quantity of coke produced, but falls behind Alabama in the value of the product. In 1909 West Virginia produced 3,943,948 tons of coke, while Alabama's production amounted to 3,085,824 tons. The value of the

West Virginia product was $7,525,922 and that of the Alabama product was $8,068,267. The average price per ton for West Virginia coke was $1.99; the average price for Alabama coke was $2.61. These figures clearly indicate the advantage possessed by Alabama in having a local market for its coke in the iron-manufacturing center of Birmingham and vicinity, whereas practically all of the West Virginia coke is shipped to furnaces outside of the State. Although West Virginia contains vast stores of high-grade coking coal and ranks second among the coal and coke producing States, its coal is sold at lower prices than that of Illinois and, as shown above, its coke brings lower prices than that of Alabama, yet West Virginia ranks thirty-fourth among the manufacturing States. The number of ovens in the State increased from 20,124 to 20,283, the number of establishments remaining the same—138. Of the 138 establishments, 36 with a total of 2,274 ovens, were idle throughout the year. Of the 36 idle establishments, 22, with a total of 1,196 ovens, were in the Upper Monongahela district. All of these had been idle for a number of years.

In the following table will be found the statistics of the manufacture of coke in West Virginia in 1880, 1890, 1900, and for the last five years:

Statistics of the manufacture of coke in West Virginia, 1880–1909.

Year.	Establishments.	Ovens.		Coal used (short tons).	Coke produced (short tons).	Total value of coke at ovens.	Value of coke at ovens, per ton.	Yield of coal in coke (per cent).
		Built.	Building.					
1880	18	631	40	230,758	138,755	$318,797	$2.30	60.0
1890	55	4,060	334	1,395,266	833,377	1,524,746	1.83	60.0
1900	106	10,249	1,306	3,868,840	2,358,499	4,746,633	2.01	60.9
1905	143	19,189	1,214	5,329,695	3,400,593	6,548,205	1.92	63.8
1906	141	19,714	353	5,822,619	3,713,514	8,192,956	2.21	63.8
1907	142	19,688	459	6,536,795	4,112,896	9,717,130	2.36	62.9
1908	138	20,124	0	4,127,730	2,637,123	5,267,054	2.00	63.9
1909	138	[a]20,283	126	6,361,759	3,943,948	7,525,922	1.99	62.0

[a] Includes 120 Semet-Solvay ovens at Benwood.

As shown in the following table, more than 60 per cent of the coal used for coke making in West Virginia is slack, nearly all of which is used without being washed. Of the 6,361,759 tons of coal charged in 1909 into the ovens, 5,926,674 tons were unwashed, and 435,085 tons were washed before being coked.

The character of the coal used in the manufacture of coke in West Virginia in 1890, 1900, and from 1905 to 1909, is shown in the following table:

Character of coal used in the manufacture of coke in West Virginia, 1890–1909, in short tons.

Year.	Run-of-mine.		Slack.		Total.
	Unwashed.	Washed.	Unwashed.	Washed.	
1890	324,847	0	930,989	139,430	1,395,266
1900	509,960	8,000	3,140,064	210,816	3,868,840
1905	1,445,099	1,950	3,577,793	304,853	5,329,695
1906	2,093,483	0	3,388,877	340,259	5,822,619
1907	2,451,811	27,067	3,874,817	183,100	6,536,795
1908	1,694,470	35,226	2,206,623	191,411	4,127,730
1909	2,282,403	32,285	3,644,271	402,800	6,361,759

PRODUCTION BY DISTRICTS.

It has been customary in the preceding reports of this series to consider the coke production by the districts into which the State has been divided. These districts are known, respectively, as the Upper Monongahela, the Upper Potomac, the Kanawha, the New River, and the Flat Top. The first two are in the northern part of the State and are named from the rivers, the Monongahela and the Potomac, by whose headwaters they are drained. The other three districts are in the southern part of the State. The New River district includes the ovens along the line of the Chesapeake and Ohio Railway and its branches from Quinnimont to Hawks Nest, near which point the coals of the New River region go below water level. The Kanawha district embraces all of the ovens along Kanawha River and its tributaries from Mount Carbon to the western limit of the coal fields. The ovens of the Gauley Mountain Coal Company at Ansted are included in the New River district, although the Ansted coal belongs in reality to the Kanawha coal series and lies about 1,000 feet above the New River coals. The Flat Top region is drained by the upper portions of New, Guyandotte, and Big Sandy rivers, and includes the ovens in West Virginia which belong to the Pocahontas coal field. The Flat Top district is by far the most important and bears the same relation to the production of West Virginia that the Connellsville district bears to that of Pennsylvania. Since 1900 the statistics of production of the Flat Top district have included the new operations along Tug River lying west of and continuous with the Flat Top district. The output from this district averages somewhat more than 50 per cent of the total coke production of the State.

The statistics of the production of West Virginia by districts in 1908 and 1909 are shown in the following table:

Production of coke in West Virginia in 1908 and 1909.

District.	Establishments.	Ovens.		Coal used (short tons).	Coke produced (short tons).	Total value of coke at ovens.	Value of coke at ovens, per ton.	Yield of coal in coke (per cent).
		Built.	Building.					
1908.								
Flat Top [a]	54	11,936	0	2,627,775	1,715,314	$3,438,228	$2.00	65.3
Kanawha	12	1,807	0	373,750	222,205	443,729	2.00	59.5
New River	23	1,873	0	348,366	203,973	521,518	2.56	58.6
Upper Monongahela	37	[b] 3,008	0	442,346	279,541	475,355	1.70	63.2
Upper Potomac and Tygarts Valley	12	1,500	0	335,493	216,090	388,224	1.80	64.4
Total	138	20,124	0	4,127,730	2,637,123	5,267,054	2.00	63.9
1909.								
Flat Top [a]	55	12,139	0	3,799,358	2,335,822	$4,340,591	$1.86	61.5
Kanawha	12	1,807	0	591,050	366,204	730,608	1.99	62.0
New River	22	1,777	0	541,233	340,268	703,621	2.07	62.9
Upper Monongahela	37	[b] 3,060	46	917,864	570,746	1,170,447	2.05	62.2
Upper Potomac and Tygarts Valley	12	1,500	80	512,254	330,908	580,655	1.71	64.6
Total	138	20,283	126	6,361,759	3,943,948	7,525,922	1.99	62.0

[a] Includes Tug River district. [b] Includes 120 Semet-Solvay ovens.

OTHER STATES.

In the following table are presented the statistics of coke production in those States in which in 1909 there were one or two establishments in operation. In 1908 there were 11 States included, viz, Indiana, Kentucky, Maryland, Massachusetts, Michigan, Minnesota, Montana, New Jersey, New York, Oklahoma, and Wisconsin. In 1909 the figures for Kentucky were published separately, and Oklahoma had no output of coke whatever. The combined production of the remaining 9 States increased from 2,286,092 short tons, valued at $8,338,363, in 1908, to 2,509,306 short tons, valued at $9,129,282, in 1909, a gain of 11.67 per cent in quantity and of 10.59 per cent in value. Six of the States included in this statement—Maryland, Michigan, Minnesota, New Jersey, New York, and Wisconsin—produced coke from coal mined in other States, and 1—Massachusetts—obtained its chief supply of coal from Nova Scotia and smaller quantities from West Virginia. All the ovens in Maryland, Massachusetts, Minnesota, New Jersey, New York, and Michigan are by-product retort ovens, and one of the two establishments in Wisconsin is also a by-product recovery plant.

The statistics of production in the States having less than three establishments since 1900 are shown in the following table:

Statistics of coke production from 1900 to 1909 in States having only one or two establishments.

Year.	Establishments.	Ovens.		Coal used (short tons).	Coke produced (short tons).	Total value of coke at ovens.	Value of coke at ovens, per ton.	Yield of coal in coke (per cent).
		Built.	Building.					
1900	10	832	594	708,295	506,730	$1,454,029	$2.87	71.5
1901	11	862	609	793,187	564,191	1,607,476	2.85	71.0
1902	11	898	742	852,977	598,869	2,063,894	3.45	70.2
1903	17	1,308	760	1,306,707	932,428	3,228,064	3.46	71.3
1904	14	1,753	658	2,046,340	1,469,845	4,830,621	3.29	71.8
1905	12	1,666	145	2,222,723	1,660,857	5,500,337	3.31	74.7
1906	12	1,952	0	2,861,934	2,085,617	7,474,889	3.58	72.9
1907	11	1,878	0	3,415,723	2,528,739	10,302,269	4.07	74.0
1908	30	3,456	103	3,155,100	2,286,092	8,338,363	3.65	72.5
1909	20	[a] 2,553	[b] 563	3,427,732	2,509,306	9,129,282	3.64	73.3

[a] Includes 398 Semet-Solvay, 1,068 United-Otto, and 282 Rothberg ovens.
[b] Includes 560 Koppers ovens.

The large proportion of by-product coke made in the States included in this statement is responsible for the high value of the product.

NATURAL GAS.

By B. Hill.

INTRODUCTION.

The natural-gas industry of the United States in the year 1909 surpassed that of any previous year in quantity and value of the gas produced. The estimated value of the gas produced from wells and consumed in 1909 was $63,206,941, as compared with $54,640,374 in 1908, a gain of $8,566,567. This increase was due to several causes: To the increased demand for gas as a result of greater prosperity in the manufacturing centers of the country, following the depression in business and financial circles in 1908; to the completion of pipe-line systems and distribution of gas into cities and districts not heretofore supplied; to the advance in the price of gas in some sections of the country; and to the more complete canvass made of the gas producers through the cooperation of the Bureau of the Census.

With continued improvement in business, greater activity in drilling operations, and the completion of the new pipe-line systems under construction in 1909, the indications are that the output of 1910 should be even greater than that of 1909.

In the tables which follow will be found complete statistics of the natural-gas business in the United States in 1909 and previous years.

PRODUCTION AND CONSUMPTION.

The following table gives, by States, the total value of the natural gas produced in the entire country from 1882 to 1909, inclusive:

Approximate value of natural gas produced in the United States, 1882–1909, by States.

State.	1882.	1883.	1884.	1885.	1886.	1887.	1888.
Pennsylvania	$75,000	$200,000	$1,100,000	$4,500,000	$9,000,000	$13,749,500	$19,282,375
New York				196,000	210,000	333,000	332,500
Ohio				100,000	400,000	1,000,000	1,500,000
West Virginia				40,000	60,000	120,000	120,000
Illinois				1,200	4,000		
Indiana					300,000	600,000	1,320,000
Kansas					6,000		
Missouri							
California							
Kentucky and Tennessee							
Texas and Alabama							
Arkansas and Wyoming							
Utah							
Colorado							
South Dakota							
Indian Territory and Oklahoma							
Louisiana							
Other	140,000	275,000	360,000	20,000	32,000	15,000	75,000
Total	215,000	475,000	1,460,000	4,857,200	10,012,000	15,817,500	22,629,875

Approximate value of natural gas produced in the United States, 1882–1909, by States—Continued.

State.	1889.	1890.	1891.	1892.	1893.	1894.	1895.
Pennsylvania	$11,593,989	$9,551,025	$7,834,016	$7,376,281	$6,488,000	$6,279,000	$5,852,000
New York	530,026	552,000	280,000	216,000	210,000	249,000	241,530
Ohio	5,215,669	4,684,300	3,076,325	2,136,000	1,510,000	1,276,100	1,255,700
West Virginia	12,000	5,400	35,000	70,500	123,000	395,000	100,000
Illinois	10,615	6,000	6,000	12,988	14,000	15,000	7,500
Indiana	2,075,702	2,302,500	3,942,500	4,716,000	5,718,000	5,437,000	5,203,200
Kansas	15,873	12,000	5,500	40,795	50,000	86,600	112,400
Missouri	35,687	10,500	1,500	3,775	2,100	4,500	3,500
California	12,680	33,000	30,000	55,000	62,000	60,350	55,000
Kentucky and Tennessee	2,580	30,000	38,993	43,175	68,500	89,200	98,700
Texas and Alabama	1,728	....	....	100	50	50	20
Arkansas and Wyoming	375	....	250	100	100	100	100
Utah	....	....	....	....	500	500	20,000
Colorado	....	....	....	....	....	12,000	7,000
South Dakota	....	....	....	....	....	....	....
Indian Territory and Oklahoma	....	....	....	....	....	....	....
Louisiana	....	....	....	....	....	....	....
Other	1,600,175	1,606,000	250,000	200,000	100,000	50,000	50,000
Total	21,107,099	18,792,725	15,500,084	14,870,714	14,346,250	13,954,400	13,006,650

State.	1896.	1897.	1898.	1899.	1900.	1901.	1902.
Pennsylvania	$5,528,610	$6,242,543	$6,806,742	$8,337,210	$10,215,412	$12,688,161	$14,352,183
New York	256,000	200,076	229,078	294,593	335,367	293,232	346,471
Ohio	1,172,400	1,171,777	1,488,308	1,866,271	2,178,234	2,147,215	2,355,458
West Virginia	640,000	912,528	1,334,023	2,335,864	2,959,032	3,954,472	5,390,181
Illinois	6,375	5,000	2,498	2,067	1,700	1,825	1,844
Indiana	5,043,635	5,009,208	5,060,969	6,680,370	7,254,539	6,954,566	7,081,344
Kansas	124,750	105,700	174,640	332,592	356,900	659,173	824,431
Missouri	1,500	500	145	290	547	1,328	2,154
California	55,682	50,000	65,337	86,891	79,083	67,602	120,648
Kentucky and Tennessee	99,000	90,000	103,133	125,745	286,243	270,871	365,656
Texas and Alabama	....	....	765	8,000	20,000	18,577	14,953
Arkansas and Wyoming	60	40	....	....	....	....	....
Utah	20,000	15,050	7,875	....	....	....	....
Colorado	4,500	4,000	3,300	1,480	1,800	1,800	1,900
South Dakota	....	....	....	3,500	9,817	7,255	10,280
Indian Territory and Oklahoma	....	....	....	....	....	....	360
Louisiana	....	....	....	....	....	....	....
Other	50,000	20,000	20,000	....	....	....	....
Total	13,002,512	13,826,422	15,296,813	20,074,873	23,698,674	27,066,077	30,867,863

State.	1903.	1904.	1905.	1906.	1907.	1908.	1909.
Pennsylvania	$16,182,834	$18,139,914	$19,197,336	$18,558,245	$18,844,156	$19,104,944	$20,475,207
New York	493,686	522,575	623,251	672,795	766,157	959,280	1,222,666
Ohio	4,479,040	5,315,564	5,721,462	7,145,809	8,718,562	8,244,835	9,966,938
West Virginia	6,882,359	8,114,249	10,075,804	13,735,343	16,670,962	14,837,130	17,538,565
Illinois	3,310	4,745	7,223	87,211	143,577	446,077	644,401
Indiana	6,098,364	4,342,409	3,094,134	1,750,715	1,572,605	1,312,507	1,616,903
Kansas	1,123,849	1,517,643	2,261,836	4,010,986	6,198,583	7,691,587	8,293,846
Missouri	7,070	6,285	7,390	7,210	17,010	22,592	10,025
California	104,521	114,195	133,696	134,560	168,397	307,652	446,933
Alabama	....	14,082	14,409				
Texas	13,851			150,695	178,276	236,837	453,253
Louisiana	....	....	1,500				
Kentucky	390,301	322,104	237,290	287,501	380,176	424,271	485,192
Tennessee	300	300	300	300	300	350	350
Arkansas and Wyoming	2,460	6,515	21,135	34,500	126,582	164,930	226,925
Colorado	14,140	14,300	20,752	22,800			
South Dakota	10,775	12,215	15,200	15,400	19,500	24,400	16,164
Oklahoma	1,000	49,665	130,137	259,862	417,221	860,159	1,806,193
North Dakota	....	....	....	....	235	2,480	3,025
Oregon	....	....	....	....	100	250	50
Iowa	....	....	....	....	....	93	50
Michigan	....	....	....	....	....	....	255
Total	35,807,860	38,496,760	41,562,855	46,873,932	54,222,399	54,640,374	63,206,941

The following table shows the production and consumption of natural gas in 1908 and 1909, by States:

Quantity and value of natural gas produced and consumed in the United States in 1908 and 1909, by States.

1908.

State.	Produced.			Consumed.		
	Quantity, M cubic feet.	Cents per M cu. ft.	Value.	Quantity, M cubic feet.	Cents per M cu. ft.	Value.
Pennsylvania	130,476,237	14.64	$19,104,944	147,790,097	13.99	$20,678,161
West Virginia	112,181,278	13.23	14,837,130	54,159,403	7.42	4,020,282
Ohio	47,442,393	17.38	8,244,835	79,906,919	18.98	15,166,434
Kansas	80,740,264	9.52	7,691,587	80,740,264	9.52	7,691,587
Indiana	5,255,792	24.97	1,312,507	5,255,792	24.97	1,312,507
New York	3,842,402	24.97	959,280	12,085,891	27.15	3,281,312
Oklahoma	11,924,574	7.21	860,159	11,924,574	7.21	860,159
Illinois	4,978,879	8.96	446,077	4,978,879	8.96	446,077
Kentucky	1,430,062	29.7	424,271	1,430,062	29.7	424,271
California	478,698	64.3	307,652	478,698	64.3	307,652
Alabama, Louisiana, Texas	1,752,372	13.5	236,837	1,752,372	13.5	236,837
Arkansas, Colorado, Wyoming	1,438,053	11.5	164,930	1,438,053	11.5	164,930
South Dakota	36,400	67.0	24,400	36,400	67.0	24,400
Missouri	152,280	14.8	22,592	152,280	14.8	22,592
North Dakota	7,960	31.2	2,480	7,960	31.2	2,480
Tennessee	2,200	15.9	350	2,200	15.9	350
Oregon	700	35.7	250	700	35.7	250
Iowa	186	50.0	93	186	50.0	93
Total	402,140,730	13.59	54,640,374	402,140,730	13.59	54,640,374

1909.

State.	Produced.			Consumed.		
	Quantity, M cubic feet.	Cents per M cu. ft.	Value.	Quantity, M cubic feet.	Cents per M cu. ft.	Value.
Pennsylvania	127,697,104	16.03	20,475,207	163,656,145	13.22	21,639,102
West Virginia	166,435,092	10.54	17,538,565	75,224,647	6.89	5,183,054
Ohio	53,222,619	18.73	9,966,938	97,867,180	19.30	18,884,312
Kansas	75,074,416	11.05	8,293,846	77,887,458	10.73	8,356,076
Oklahoma	28,036,976	6.44	1,806,193	25,223,934	6.91	1,743,963
Indiana	6,159,029	26.25	1,616,903	6,159,029	26.25	1,616,903
New York	4,695,735	26.04	1,222 666	13,204,982	24.89	3,286,523
Illinois	8,472,860	7.61	644,401	8,472,860	7.61	644,401
Kentucky	2,097,471	23.13	485,192	4,195,067	16.58	695,577
Louisiana, Texas, Alabama	4,365,335	10.38	453,253	4,365,335	10.38	453,253
California	2,323,747	19.23	446,933	2,323,747	19.23	446,933
Arkansas, Colorado, Wyoming	2,042,049	11.11	226,925	2,042,049	11.11	226,925
South Dakota	22,764	71.00	16,164	22,764	71.00	16,164
Missouri	49,117	20.41	10,025	49,117	20.41	10,025
North Dakota	8,950	33.80	3,025	8,950	33.80	3,025
Tennessee	2,200	15.91	350	2,200	15.91	350
Michigan	510	50.00	255	510	50.00	255
Iowa	100	50.00	50	100	50.00	50
Oregon	100	50.00	50	100	50.00	50
Total	480,706 174	13.15	63,206,941	480,706,174	13.15	63,206,941

The following tables show the distribution of natural gas consumed in 1908 and 1909, by States:

Distribution of natural gas consumed in the United States in 1908, by States, and total for 1906 and 1907.

State.	Number of producers having gas wells.	Consumers.		Gas consumed.		
				Domestic.		
		Domestic.	Industrial.	Quantity, M cubic feet.	Cents per M cubic feet.	Value.
Pennsylvania	572	307,585	4,577	42,202,868	24.0	$10,141,517
Ohio	970	427,276	3,621	43,848,494	25.1	10,999,202
Kansas [a]	212	168,855	1,162	23,140,099	20.1	4,647,157
West Virginia [b]	138	63,228	1,225	10,688,856	16.5	1,764,547
New York	215	91,391	213	10,856,613	28.6	3,105,585
Indiana	823	42,054	216	3,957,133	28.0	1,108,001
Oklahoma	115	17,567	356	2,562,201	17.6	451,906
Illinois	185	7,377	204	1,050,252	18.5	194,859
Kentucky	38	21,778	42	1,194,661	33.2	396,179
California	24	6,623	188	144,103	97.5	140,567
Alabama	3	642	1			
Louisiana	6	4,400	57	472,320	28.1	132,950
Texas	24	1,225	18			
Arkansas	6	4,199	42			
Colorado	5	901	3	381,986	26.1	99,599
Wyoming	7	21	3			
South Dakota	28	362	28	26,000	73.5	19,100
Missouri	29	505	5	55,100	22.7	12,499
North Dakota	8	12	2	1,960	50.0	980
Tennessee	4	2	1	600	25.0	150
Oregon	3	2	1	300	50.0	150
Iowa	7	3	....	186	50.0	93
Total	3,422	1,166,008	11,965	140,583,732	23.6	33,215,041
Total for 1907	2,407	1,058,181	13,005	131,377,587	23.66	31,084,974
Total for 1906	1,871	874,944	9,074	110,405,808	22.7	25,149,097

State.	Gas consumed—Continued.					
	Industrial.			Total.		
	Quantity, M cubic feet.	Cents per M cubic feet.	Value.	Quantity, M cubic feet.	Cents per M cubic feet.	Value.
Pennsylvania	105,587,229	10.0	$10,536,644	147,790,097	13.99	$20,678,161
Ohio	36,058,425	11.6	4,167,232	79,906,919	18.98	15,166,434
Kansas [a]	57,600,165	5.3	3,044,430	80,740,264	9.52	7,691,587
West Virginia [b]	43,470,547	5.2	2,255,735	54,159,403	7.42	4,020,282
New York	1,229,278	14.3	175,727	12,085,891	27.15	3,281,312
Indiana	1,298,659	15.7	204,506	5,255,792	24.97	1,312,507
Oklahoma	9,362,373	4.4	408,253	11,924,574	7.21	860,159
Illinois	3,928,627	6.4	251,218	4,978,879	8.96	446,077
Kentucky	235,401	11.9	28,092	1,430,062	29.7	424,271
California	334,595	49.9	167,085	478,698	64.3	307,652
Alabama						
Louisiana	1,280,052	8.1	103,887	1,752,372	13.5	236,837
Texas						
Arkansas						
Colorado	1,056,067	6.2	65,331	1,438,053	11.5	164,930
Wyoming						
South Dakota	10,400	51.0	5,300	36,400	67.0	24,400
Missouri	97,180	10.4	10,093	152,280	14.8	22,592
North Dakota	6,000	25.0	1,500	7,960	31.2	2,480
Tennessee	1,600	12.5	200	2,200	15.9	350
Oregon	400	25.0	100	700	35.7	250
Iowa	....	....	....	186	50.0	93
Total	261,556,998	8.19	21,425,333	402,140,730	13.59	54,640,374
Total for 1907	275,244,532	8.4	23,137,425	406,622,119	13.33	54,222,399
Total for 1906	278,436,754	7.8	21,724,835	388,842,562	12.1	46,873,932

[a] Includes the consumption of gas piped from Kansas to Missouri.
[b] Includes the consumption of gas piped from West Virginia to Maryland.

Distribution of natural gas consumed in the United States in 1909, by States.

State.	Producers.			Consumers.		Gas consumed.		
						Domestic.		
	Reporting gas wells.	Reporting gas from oil wells.	Total.	Domestic.	Industrial.	Quantity, M cubic feet.	Cents per M cubic feet.	Value.
Pennsylvania	777	1,581	2,358	294,781	5,337	39,729,064	24.4	$9,691,804
Ohio	1,534	641	2,175	450,973	5,260	50,356,496	26.8	13,503,091
Kansas [a]	199	39	238	182,657	1,160	23,863,178	20.6	4,923,702
West Virginia [b]	183	178	361	70,853	1,907	12,089,067	16.4	1,985,232
New York	282	373	655	92,958	570	11,290,837	27.2	3,068,150
Oklahoma	131	317	448	32,907	1,527	4,393,368	16.4	721,477
Indiana	1,010	112	1,122	40,565	369	4,666,554	30.2	1,407,313
Kentucky	38	22	60	25,639	137	1,946,528	26.5	515,941
Illinois	194	210	404	8,458	518	1,270,421	19.5	248,318
Texas	17	15	32	5,035	130			
Louisiana	11	....	11	4,034	164	771,077	27.1	208,774
Alabama	5	....	5	500	1			
California	35	96	131	7,612	104	224,780	90.4	203,156
Arkansas	4	....	4	4,310	45			
Colorado	3	9	12	906	10	561,296	25.2	141,458
Wyoming	4	1	5	233	6			
South Dakota	35	....	35	374	6	16,964	71.7	12,164
Missouri	29	2	31	401	5	36,533	19.5	7,129
North Dakota	16	....	16	231	2	4,750	41.6	1,975
Tennessee	5	....	5	2	1	600	25.0	150
Michigan	4	....	4	4	....	510	50.0	255
Iowa	6	....	6	4	....	100	50.0	50
Oregon	1	....	1	1	....	100	50.0	50
Total	4,523	3,596	8,119	1,223,438	17,259	151,222,223	24.23	36,640,189

State.	Gas consumed—Continued.					
	Industrial.			Total.		
	Quantity, M cubic feet.	Cents per M cubic feet.	Value.	Quantity, M cubic feet.	Cents per M cubic feet.	Value.
Pennsylvania	123,927,081	9.6	$11,947,298	163,656,145	13.22	$21,639,102
Ohio	47,510,684	11.3	5,381,221	97,867,180	19.30	18,884,312
Kansas [a]	54,024,280	6.4	3,432,374	77,887,458	10.73	8,356,076
West Virginia [b]	63,135,580	5.1	3,197,822	75,224,647	6.89	5,183,054
New York	1,914,145	11.4	218,373	13,204,982	24.89	3,286.523
Oklahoma	20,830,566	4.9	1,022,486	25,223,934	6.91	1,743,963
Indiana	1,492,475	14.0	209,590	6,159,029	26.25	1,616,903
Kentucky	2,248,539	8.0	179,636	4,195,067	16.58	695,577
Illinois	7,202,439	5.5	396,083	8,472,860	7.61	644,401
Texas						
Louisiana	3,594,258	6.8	244,479	4,365,335	10.38	453,253
Alabama						
California	2,098,967	11.6	243,777	2,323,747	19.23	446,933
Arkansas						
Colorado	1,480,753	5.8	85,467	2,042,049	11.11	226,925
Wyoming						
South Dakota	5,800	69.0	4,000	22,764	71.00	16,164
Missouri	12,584	23.0	2,896	49,117	20.41	10,025
North Dakota	4,200	25.0	1,050	8,950	33.80	3,025
Tennessee	1,600	12.5	200	2,200	15.91	350
Michigan	....	....	....	510	50.0	255
Iowa	....	....	....	100	50.0	50
Oregon	....	....	....	100	50.0	50
Total	329,483,951	8.06	26,566,752	480,706,174	13.15	63,206,941

[a] Includes the consumption of gas piped from Kansas to Missouri.
[b] Includes the consumption of gas piped from West Virginia to Maryland.

Distribution of gas consumed for industrial purposes in 1909, by States.

State.	Manufacturing.			Other industrial (power).			Total industrial.		
	Quantity, M cubic feet.	Cents per M cubic feet.	Value.	Quantity, M cubic feet.	Cents per M cubic feet.	Value.	Quantity, M cubic feet.	Cents per M cubic feet.	Value.
Pennsylvania	113,903,482	9.5	$10,903,656	10,023,599	10.4	$1,043,642	123,927,081	9.6	$11,947,298
Ohio	41,999,918	11.5	4,812,946	5,510,766	10.3	568,275	47,510,684	11.3	5,381,221
Kansas	52,763,507	6.4+	3,378,114	1,260,773	4.3	54,260	54,024,280	6.4−	3,432,374
West Virginia	43,304,336	4.9	2,152,111	19,831,244	5.3	1,045,711	63,135,580	5.1	3,197,822
Oklahoma	9,776,750	3.4	329,675	11,053,816	6.3	692,811	20,830,566	4.9	1,022,486
Illinois	1,155,230	8.9	102,320	6,047,209	4.8	293,763	7,202,439	5.5	396,083
Texas, Louisiana, Alabama	1,680,177	8.9	148,707	1,914,081	5.0	95,772	3,594,258	6.8	244,479
California	....	....	....	2,098,967	11.6	243,777	2,098,967	11.6	243,777
New York	405,217	16.6	67,375	1,508,928	10.0	150,998	1,914,145	11.4	218,373
Indiana	797,314	14.6	116,223	695,161	13.4	93,367	1,492,475	14.0	209,590
Kentucky	2,119,691	7.5	159,984	128,848	15.3	19,652	2,248,539	8.0	179,636
Arkansas, Colorado, Wyoming	(a)	....	(a)	1,480,753	5.8	85,467	1,480,753	5.8	85,467
South Dakota	....	....	....	5,800	69.0	4,000	5,800	69.0	4,000
Missouri	....	....	....	12,584	23.0	2,896	12,584	23.0	2,896
North Dakota	....	....	....	4,200	25.0	1,050	4,200	25.0	1,050
Tennessee	....	....	....	1,600	12.5	200	1,600	12.5	200
Total	267,905,622	8.28	22,171,111	61,578,329	7.14	4,395,641	329,483,951	8.06	26,566,752

[a] Included in other industrial.

Value of natural gas consumed in the United States, 1904–1909, by States.

State.	1904.	1905.	1906.	1907.	1908.	1909.
Pennsylvania	$17,205,804	$19,237,218	$21,085,077	$22,917,547	$20,678,161	$21,639,102
Ohio	9,393,843	10,396,633	12,652,520	15,227,780	15,166,434	18,884,312
Kansas	1,517,643	2,265,945	[a] 4,030,776 (Kansas and Missouri)	[a] 6,208,862	[a] 7,691,587	[a] 8,356,076
Missouri	6,285	7,390		17,010	22,592	10,025
West Virginia	3,383,515	3,586,608	3,720,440	[b] 3,757,977	[b] 4,020,282	[b] 5,183,054
New York	2,222,980	2,434,894	2,654,115	3,098,533	3,281,312	3,286,523
Indiana	[c] 4,282,409	[c] 3,056,634	[c] 1,750,755	[c] 1,570,605	[c] 1,312,507	[c] 1,616,903
Kentucky	268,264	237,290	287,501	380,176	424,271	695,577
Oklahoma	49,665	126,028	247,282	406,942	860,159	1,743,963
Alabama, Texas	14,082	14,409	150,695 (Alabama, Texas, and Louisiana)	178,276	236,837	453,253
Louisiana	....	1,500				
California	114,195	133,696	134,560	168,397	307,652	446,933
Illinois	4,745	7,223	87,211	143,577	[d] 446,077	[d] 644,401
Arkansas, Wyoming	6,515	21,135	34,500	126,582 (Arkansas, Wyoming, and Colorado)	164,930	226,925
Colorado	14,300	20,752	22,800			
South Dakota	12,215	15,200	15,400	19,500	24,400	16,164
Tennessee	300	300	300	300	350	350
North Dakota	....	....	....	235	2,480	3,025
Oregon	....	....	....	100	250	50
Iowa	....	....	....	....	93	50
Michigan	....	....	....	....	....	255
Total	38,496,760	41,562,855	46,873,932	54,222,399	54,640,374	63,206,941

[a] Includes value of gas piped from Kansas to Missouri.
[b] Includes value of gas piped from West Virginia to Maryland.
[c] A portion of this was consumed in Chicago, Ill.
[d] Includes value of gas consumed in Vincennes, Ind.

COMBINED VALUE OF NATURAL GAS AND PETROLEUM.

The following tables give the value of natural gas and of petroleum and their combined value in 1908 and 1909, by States, arranged in the order of the value of the combined production:

Value of the natural gas and petroleum produced in 1908 and 1909, and their combined value, by States.

1908.

State.	Value of natural gas.	Value of crude petroleum.	Value of natural gas and crude petroleum.
Pennsylvania	$19,104,944	$16,881,194	$35,986,138
West Virginia	14,837,130	16,911,865	31,748,995
California	307,652	23,433,502	23,741,154
Illinois	446,077	22,649,561	23,095,638
Ohio	8,244,835	14,178,502	22,423,337
Oklahoma	860,159	17,694,843	18,555,002
Texas		6,700,708	
Louisiana	236,837	3,503,419	10,440,964
Alabama		....	
Kansas	7,691,587	746,695	8,438,282
Indiana	1,312,507	3,203,883	4,516,390
New York	959,280	2,071,533	3,030,813
Kentucky	424,271	706,811	1,131,082
Arkansas		....	
Colorado	164,930	346,403	
Wyoming			584,190
Missouri	22,592	50,265	
Michigan			
Utah	....		
South Dakota	24,400	....	24,400
North Dakota	2,480	....	2,480
Tennessee	350	....	350
Oregon	250	....	250
Iowa	93	....	93
Total	54,640,374	129,079,184	183,719,558

1909.

State.	Value of natural gas.	Value of crude petroleum.	Value of natural gas and crude petroleum.
Pennsylvania	$20,475,207	$15,424,554	$35,899,761
West Virginia	17,538,565	17,642,283	35,180,848
California	446,933	30,675,267	31,122,200
Ohio	9,966,938	13,225,377	23,192,315
Illinois	644,401	19,788,864	20,433,265
Oklahoma	1,806,193	17,428,990	19,235,183
Alabama		....	
Louisiana	453,253	2,022,449	9,268,752
Texas		6,793,050	
Kansas	8,293,846	491,633	8,785,479
Indiana	1,616,903	1,997,610	3,614,513
New York	1,222,666	1,878,217	3,100,883
Kentucky	485,192	518,299	1,003,491
Arkansas			
Colorado	226,925	317,712	581,285
Wyoming		36,648	
Utah	....		
Michigan	255		
Missouri	10,025	7,830	18,110
South Dakota	16,164	....	16,164
North Dakota	3,025	....	3,025
Tennessee	350	....	350
Oregon	a 50	....	50
Iowa	50	....	50
Total	63,206,941	128,248,783	191,455,724

a Estimated.

WELL RECORD.

The following table gives the record of natural gas wells in 1909, by States:

Record of natural gas wells in 1909, by States.

State.	Productive Dec. 31, 1908.	Drilled in 1909.			Abandoned in 1909.	Productive Dec. 31, 1909.
		Gas.	Dry.	Total.		
Alabama	11	5		5		16
Arkansas	55	8	3	11	1	62
California	62	7		7	5	64
Colorado	3					3
Illinois	400	56	11	67	42	414
Indiana	3,223	190	70	260	475	2,938
Iowa	6					6
Kansas	1,966	452	214	666	280	2,138
Kentucky	218	26	7	33	32	212
Louisiana	32	26	10	36		58
Michigan	3	1		1		*a* 4
Missouri	45	5	17	22	8	42
New York	1,211	86	18	104	18	1,279
North Dakota	15	8	7	15	4	*b* 19
Ohio	3,691	548	149	697	197	4,042
Oklahoma	350	97	35	132	32	415
Oregon	1					*a* 1
Pennsylvania	8,831	756	166	926	274	9,313
South Dakota	33	4		4		*a* 37
Tennessee	5					5
Texas	28	7	6	13	5	30
West Virginia	2,511	642	65	707	79	3,074
Wyoming	9	3		3		12
Total	22,709	2,927	778	3,705	1,452	24,184

a Artesian wells from which gas is used.
b Includes 7 artesian wells from which gas was used.

ACREAGE CONTROLLED BY NATURAL GAS COMPANIES.

The following table shows the number of acres of land held by natural gas companies in 1908 and 1909 and whether the acreage was owned in fee or leased:

Acreage controlled by natural gas companies in 1908 and 1909, by States.

State.	1908.			1909.			
	In fee.	Leased.	Total.	In fee.	Leased.	Gas rights.	Total.
Alabama	570	25,000	25,570	570	23,000		23,570
Arkansas	3,800	134,103	137,903	530	42,404	3,114	46,048
California	342	800	1,142	625	2,001	800	3,426
Colorado		78	78		35		35
Illinois		60,648	60,648	1,234	63,170	2,151	66,555
Indiana	23,029	117,130	140,159	51,318	142,750	24,596	218,664
Kansas	32,879	628,112	660,991	29,883	506,706	10,217	546,806
Kentucky	308	72,029	72,337	64	120,388	23,333	143,785
Louisiana	3,466	8,005	11,471	19,490	293,273		312,763
Missouri	1,831	25,535	27,366	364	2,010		2,374
New York	3,670	151,877	155,547	10,285	173,126	7,312	190,723
North Dakota		23,000	23,000		20,320		20,320
Ohio	7,287	860,508	867,795	15,123	1,059,996	19,850	1,094,969
Oklahoma	11,017	933,739	944,756	4,647	109,130	747,953	861,730
Pennsylvania	350,075	1,508,809	1,858,884	116,315	1,509,462	220,299	1,846,076
Tennessee	500		500	500			500
Texas	155	31,455	31,610	1,845	19,653	131,597	153,095
West Virginia	41,683	2,249,552	2,291,235	17,606	2,564,273	631,080	3,212,959
Wyoming	250	2,990	3,240	944	1,640		2,584
Total	480,862	6,833,370	7,314,232	271,343	6,653,337	1,822,302	8,746,982

NATURAL-GAS INDUSTRY BY STATES.

PENNSYLVANIA.

Pennsylvania still holds first place among the States in the value of gas produced and consumed and in the combined value of its production of gas and petroleum.

The total value of the gas consumed in this State in 1909 was $21,639,102, as compared with $20,678,161 in 1908, an increase of $960,941. Reference to the table of distribution of natural gas shows that this State gained in industrial consumption, the quantity of gas consumed for industrial purposes in 1909 being 123,927,081,000 cubic feet, valued at $11,947,298, as compared with 105,587,229,000 cubic feet, valued at $10,536,644, in 1908, an increase of 18,339,852,000 cubic feet in quantity and of $1,410,654 in value. This increase was largely the result of improved conditions in the iron and steel industry and allied trades, there being a greater demand for gas for manufacturing purposes in 1909 than in 1908. An effort was made to obtain from oil producers an estimate of the value of the gas consumed for field purposes in 1909, and the industrial consumption includes 2,543,748,000 cubic feet of gas, valued at $335,129, consumed in drilling and operating in this State by 1,489 oil producers.

The quantity and value of gas consumed for domestic purposes declined from 42,202,868,000 cubic feet, valued at $10,141,517, in 1908, to 39,729,064,000 cubic feet, valued at $9,691,804, in 1909, a reduction of 2,473,804,000 cubic feet in quantity and of $449,713 in value; the average price received for gas increased from 24 cents per 1,000 cubic feet in 1908 to 24.4 cents in 1909. The price of gas ranged from 2½ cents per 1,000 cubic feet at the wells for gas sold for manufacturing purposes to 60 cents per 1,000 cubic feet for gas sold for domestic purposes.

No new gas fields were reported in 1909, but drilling operations were active, resulting in the completion of 756 gas wells and 166 dry holes, the total number of productive gas wells at the close of 1909 being 9,313.

A new feature in connection with the gas industry in 1909 was the installation of a few plants in the Pennsylvania oil fields for the extraction of gasoline from natural gas. The plants are located near the oil wells, the purpose being to treat the surplus gas from the oil wells by a process of compressing and cooling. The yield of gasoline per 1,000 cubic feet of gas is not known. At most of the plants in operation no meters are used, and therefore no accurate figures as to quantity of gas used were obtainable.

Record of natural-gas industry in Pennsylvania, 1897–1909.

Year.	Gas produced.		Gas consumed.			Wells.		
	Number of producers.	Value.	Number of consumers.		Value.	Drilled.		Productive Dec. 31.
			Domestic.	Industrial.		Gas.	Dry.	
1897	176	$6,242,543	[a] 201,059	1,124	$5,392,661	314	96	2,467
1898	232	6,806,742	[a] 213,410	1,021	6,064,477	373	74	2,840
1899	281	8,337,210	[a] 232,060	1,236	7,926,970	467	104	3,303
1900	266	10,215,412	[a] 229,730	1,296	9,812,615	513	142	3,776
1901	296	12,688,161	[a] 326,912	1,743	11,785,996	660	143	4,436
1902	379	14,352,183	185,678	2,448	13,942,783	775	232	5,211
1903	414	16,182,834	214,432	2,834	16,060,196	699	126	5,910
1904	414	18,139,914	238,481	2,929	17,205,804	701	174	6,352
1905	351	19,197,336	257,416	2,845	19,237,218	765	168	6,566
1906	309	18,558,245	273,184	3,307	21,085,077	603	153	7,300
1907	344	18,844,156	295,115	3,812	22,917,547	769	180	8,051
1908	[b] 572	19,104,944	307,585	4,577	20,678,161	571	147	[c] 8,831
1909	[b] 777	20,475,207	294,781	5,377	21,639,102	756	166	[c] 9,313

[a] Number of fires supplied.
[b] Includes 216 producers having shallow wells in Erie County for their own domestic consumption in 1908 and 311 producers in 1909.
[c] Includes 350 shallow wells in Erie County in 1908 and 386 wells in 1909.

Depth and gas pressure of wells in Pennsylvania, 1906 to 1909, by counties.

County.	Depth, in feet.	Pressure, in pounds.			
		1906.	1907.	1908.	1909.
Allegheny	900–3,000	1– 380	7– 400	1–350	10–600
Armstrong	702–3,000	7– 900	6– 800	2–600	25–900
Beaver	700–1,500		4		4–600
Butler	800–2,600	22– 700	15– 625	15–550	30–600
Clarion	600–3,000	6– 450	3– 700	15–500	8–800
Elk	910–3,200	50– 990	49– 960	50–940	50–990
Crawford	600– 900	25– 100	10– 200	100	1– 85
Erie	300–1,600				
Fayette and Cambria	900–2,500	28– 300	100– 550	200–550	100–700
Forest	700–2,600	6– 90	75– 250	85–160	15–145
Greene	1,400–3,600	80– 350	80–1,200	70–350	50–500
Indiana	1,100–1,500				
Jefferson	1,350–3,040	70– 800	200– 500	325–760	10–635
McKean	750–2,665	18– 880	20– 450	15–500	30–600
Mercer	700–1,500	30– 150			40
Potter	750–2,200	125– 400	40– 360	100–460	60–500
Tioga	730–1,400		350	300	250
Venango	400–2,100	90– 200	70– 150	40–400	20–250
Warren	600–2,050	20– 100	10– 60	14–250	20– 50
Washington	606–3,304	30–1,300	15– 100	5–400	12–500
Westmoreland	1,800–3,300	80– 100	25	10– 30	50–180

NEW YORK.

There has been a steady increase in the production of natural gas in New York since 1901. The reported value of gas produced from gas and oil wells in the State in 1909 was $1,222,666, as compared with $959,280 in 1908 and with $766,157 in 1907. The report shows a continued increasing quantity of gas consumed in the State, which is dependent upon the fields of Pennsylvania for the greater portion of its supply. In 1909 the value of gas consumed in this State was $3,286,523, or $5,211 more than in 1908. As in past years, the larger part of the gas consumed was utilized for domestic purposes, the quantity consumed in 1909 amounting to 11,290,837,000 cubic feet, valued at $3,068,150, the average price for the year being 27.2

cents per thousand cubic feet. The gas supplied for industrial consumption is chiefly used for power, very little being consumed for manufacturing purposes.

The quantity of gas produced from the oil wells of this State and consumed for field purposes in 1909, as reported by 341 oil producers in Allegany, Cattaraugus, and Steuben counties, was estimated to be 513,918,000 cubic feet, valued at $43,029. A few plants were installed for the production of gasoline from surplus gas from the oil wells of this State.

During 1909 the number of wells completed in this State was 104, of which 86 were gas wells and 18 dry holes. The number of productive gas wells at the close of 1909 was 1,279, which included 200 shallow wells in Chautauqua County, producing only sufficient gas for one or two families. There are in this county a number of deep wells which produced gas for commercial purposes. Only 18 gas wells were abandoned in 1909.

The following table gives the statistics of the natural-gas industry in New York from 1897 to 1909, inclusive:

Record of natural-gas industry in New York, 1897–1909.

Year.	Gas produced.		Gas consumed.			Wells.		
	Number of producers.	Value.	Number of consumers.		Value.	Drilled.		Productive Dec 31.
			Domestic.	Industrial.		Gas.	Dry.	
1897	41	$200,076	*a* 55,086	80	$874,617	33	7	359
1898	62	229,078	*a* 68,662	103	1,006,567	63	9	422
1899	84	294,593	*a* 76,544	121	1,236,007	36	7	447
1900	89	335,367	*a* 84,837	138	1,456,286	57	11	504
1901	114	293,232	*a* 95,161	98	1,694,925	53	14	557
1902	116	346,471	50,536	215	1,723,709	69	8	626
1903	144	493,686	57,935	208	1,944,667	75	11	700
1904	153	522,575	67,203	451	2,222,980	78	12	744
1905	148	623,251	67,848	447	2,434,894	89	17	839
1906	143	672,795	74,538	95	2,654,115	64	14	919
1907	208	766,157	83,805	155	3,098,533	61	13	1,049
1908	215	959,280	91,391	213	3,281,312	68	19	1,211
1909	282	1,222,666	92,958	570	3,286,523	86	18	1,279

a Number of fires supplied.

Depth and gas pressure of wells in New York, 1906–1909, by counties.

County.	Depth, in feet.	Pressure, in pounds.			
		1906.	1907.	1908.	1909.
Allegany	600–1,700	30–250	10–150	10–200	6–300
Cattaraugus	400–2,300	20– 90	5– 85	4–150	8–250
Chautauqua	150–2,471	5–650	1–800	1–800	0–800
Erie	360–2,980	56–400 (Erie and Niagara)	40–585	25–500	25–500
Niagara	550		....	150	150
Genesee	1,150–1,850	....	300–580	600	600
Livingston	345–2,000	5– 10	10	1–350	15–450
Monroe	550–1,025	....	....	....	....
Onondaga	1,000–3,000	100–350	100	100–350	....
Ontario	650–2,300	10–600 (Ontario and Seneca)	65–425	65–510	60–480
Seneca	1,450–1,550				
Oswego	700–1,300	4–400	....	....	3–200
Schuyler	1,000–1,400	100–435 (Schuyler and Yates)	100–435	15–100	100–435
Yates	1,200–1,900				
Steuben	279– 850	70–300	....	25	....
Wyoming	1,638–1,913	120–200	140–200	100–200	200

WEST VIRGINIA.

The report shows that in point of output of natural gas West Virginia proved to be the banner State in 1909, having an estimated total production of 166,435,092,000 cubic feet, valued at $17,538,565, as compared with a production in Pennsylvania of 127,697,104,000 cubic feet, valued at $20,475,207. The figures of production in West Virginia must be considered only approximate, as much of the gas produced in the State is used and sold without measurement, and it is therefore impossible to arrive at a correct statement of quantity.

It is estimated that the value of the gas consumed in the State in 1909 amounted to $5,183,054, a gain of $1,162,772, as compared with $4,020,282 in 1908. The greater part of the gas consumed in the State is used for manufacturing or industrial purposes, and much of it is sold at a very low rate. Immense quantities are used in the manufacture of carbon black, the estimated quantity consumed for this purpose aggregating 19,046,282,000 cubic feet, valued at $423,730, in 1909, there being 19 carbon-black factories operating in the State. As there is no market within the State for all the gas produced a considerable quantity produced from gas wells, as also from oil wells, is sold by the producers to the large pipe-line companies at a low price at the wells and piped by them from the State. Many towns and cities in Ohio, Pennsylvania, Kentucky, and Maryland are supplied with gas from the fields of West Virginia. Upon the completion of the pipe line from this State to Covington, Ky., and Cincinnati, Ohio, these cities were supplied in 1909. An increasing quantity of gas is also being supplied to towns in Maryland.

The value of the gas reported as produced in this State from oil wells and used for field purposes by 167 oil producers amounted to $50,782 in 1909, the estimated quantity of gas consumed being 969,901,000 cubic feet. Gas engines are almost exclusively used, having taken the place of the steam engine, which requires twice the quantity of gas for operation that the gas engine needs. A gasoline plant was being installed in Hancock County, this State, in 1909 to use gas from oil wells, and others will doubtless follow.

The price of gas varied from $1\frac{1}{4}$ cents per thousand cubic feet at the well, the lowest price received for gas sold for the manufacture of carbon black, to 27 cents per thousand cubic feet, the highest price received for gas supplied for domestic use. Manufacturers in this State other than carbon-black manufacturers paid in 1909 from 4 to 11 cents per thousand cubic feet for gas, the average price being about 7 cents. The average price received in 1909 per thousand cubic feet for all gas consumed in the State was 6.89 cents, practically the same as in 1907 and a little lower than in 1908, when the average price was 7.42 cents.

The number of gas wells in West Virginia at the close of 1909 was 3,074, of which 642 were completed in 1909. The number of dry holes drilled in 1909 was 65, a very small proportion of the total number drilled. The number of gas wells abandoned in 1909 was 79.

A glance at the table giving acreage controlled by gas companies at the close of 1909 shows that the quantity of land leased and in which gas rights were held by these companies in West Virginia exceeds that of any other State. Further developments in this territory, much of which has not yet been exploited, will no doubt furnish gas for many years to come.

Record of natural-gas industry in West Virginia, 1897–1909.

Year.	Gas produced.		Gas consumed.			Wells.		
	Number of producers.	Value.	Number of consumers.		Value.	Drilled.		Productive Dec. 31.
			Domestic.	Industrial.		Gas.	Dry.	
1897	12	$912,528	[a] 30,015	393	$791,192	47	1	196
1898	19	1,334,023	[a] 28,652	125	914,969	32	4	227
1899	30	2,335,864	[a] 38,137	305	1,310,675	78	6	300
1900	34	2,959,032	[a] 45,9[illegible]3	184	1,530,378	129	6	428
1901	44	3,954,472	[a] 55,808	266	2,244,758	177	8	604
1902	79	5,390,181	29,357	877	2,473,174	142	37	745
1903	88	6,882,359	36,179	1,122	3,125,061	242	43	987
1904	90	8,114,249	44,563	1,005	3,383,515	292	33	1,274
1905	76	10,075,804	45,588	1,417	3,586,608	385	28	1,579
1906	67	13,735,343	51,281	913	3,720,440	263	23	1,831
1907	105	16,670,962	53,807	1,000	[b] 3,757,977	377	59	2,169
1908	138	14,837,130	63,228	1,225	[b] 4,020,282	253	80	2,511
1909	183	17,538,565	70,853	1,907	[b] 5,183,054	642	65	3,074

[a] Number of fires supplied. [b] Includes gas consumed in Maryland.

Depth and gas pressure of wells in West Virginia, 1906 to 1909, by counties.

County.	Depth, in feet.	Pressure, in pounds.			
		1906.	1907.	1908.	1909.
Braxton	2,250–3,000				
Clay	1,650–1,992	...	250–900	250–500	240– 525
Taylor	2,100				
Brooke	1,200–1,700	...	100	30–600	100– 600
Cabell	900–2,325	350– 650	300–625	230–650	200– 460
Calhoun	824–4,000	300	200–600	25–400	60–1,400
Doddridge	1,650–3,000	100– 900	180–620	70–580	100– 800
Gilmer	1,280–2,873	465	...	...	250– 875
Hancock	700–1,400	80– 90	15–300	1–220	10– 150
Harrison	800–3,092	325–1,000	105–975	150–800	50– 900
Kanawha	1,500–2,585	...	...	...	500
Lewis	1,510–3,000	200– 900	250–900	275–750	200– 720
Lincoln	1,200–2,720	...	500	585	250– 450
Marion	1,500–3,207	400– 750	300–350	100–700	125– 580
Marshall	1,000–2,900	...	...	160–300	200– 300
Monongalia	1,350–3,500	150– 500	140–450	40–400	85– 500
Pleasants	900–2,001	...	50–300	200–350	100– 250
Putnam	900–2,400	...	...	...	300– 800
Upshur	2,000–2,800	...	...	...	
Ritchie	915–2,200	...	...	25–670	45– 670
Roane	1,472–2,350	...	3[illegible]0	500–700	400– 500
Tyler	1,650–2,700	80	160–550	40–340	65– 300
Wetzel	2,000–3,375	42– 50	125–242	65–300	95– 250
Wirt	500–1,800	60– 530	20–530	30–500	40– 500
Wood	1,080–1,635	...	...	40–150	250– 540

KENTUCKY.

There was little change in the natural-gas industry in Kentucky since the report for 1908. The value of the gas produced in the State was $485,192, or $60,921 more than 1908. Barboursville, Louisville, Lexington, Winchester, Mount Sterling, Hazel Green, Burning

Springs, and West Point were supplied in 1909 with gas from wells in Knox, Meade, Clay, Hardin, Menifee, Powell, Wolfe, and Morgan counties, and Central City, Diamond Springs, Lewisburg, Russellville, and Dunmore were being piped for gas to be supplied from wells in Logan and Muhlenberg counties.

This State receives part of its gas from the gas fields of West Virginia, the city of Covington being wholly supplied from this source in 1909, while Ashland, Buchanan, Kinner, Louisa, Inez, Warfield, Kavanaugh, Catlettsburg, and Russell were partly supplied from West Virginia and partly from wells in Martin County, Ky. The total quantity of gas consumed in Kentucky in 1909 was 4,195,067,000 cubic feet, valued at $695,577, an average price of 16.58 cents per thousand cubic feet. It will be noted that about one-half of the gas consumed in the State in 1909 was utilized for domestic purposes, amounting to 1,946,528,000 cubic feet, for which $515,941 was received, an average price of 26.5 per thousand cubic feet. The quantity of gas consumed for industrial purposes was 2,248,539,000 cubic feet, valued at $179,636, or 8 cents per thousand cubic feet. In the figures of industrial consumption are included 64,364,000 cubic feet of gas, valued at $8,717, which were reported as the quantity and value of gas produced from oil wells in Wayne and Wolfe counties and used for field operations in 1909.

During the year 1909 there were 26 gas wells drilled in Kentucky, making the total number of gas wells 212 at the close of the year.

Record of natural-gas industry in Kentucky, 1906 to 1909.

Year.	Gas produced.		Gas consumed.			Wells.		
	Number of producers.	Value.	Number of consumers.		Value.	Drilled.		Productive Dec. 31.
			Domestic.	Industrial.		Gas.	Dry.	
1906	45	$287,501	17,216	18	$287,501	......	......	166
1907	38	380,176	19,279	239	380,176	31	14	179
1908	38	424,271	21,778	42	424,271	19	23	218
1909	38	485,192	25,639	137	695,577	26	7	212

OHIO.

Ohio, like New York, depends upon gas fields outside of the State for a great portion of its gas, West Virginia being the chief source of supply, though a comparatively small quantity of gas is piped from Pennsylvania.

The total quantity of gas produced from wells and consumed in 1909 was 53,222,619,000 cubic feet, for which $9,966,938 was received, an average price of 18.73 cents per thousand cubic feet, as compared with 47,442,393,000 cubic feet in 1908, valued at $8,244,835, or 17.38 cents per thousand cubic feet. On the other hand, the quantity of gas consumed in 1909 amounted to 97,867,180,000 cubic feet, valued at $18,884,312, or 19.30 cents per thousand cubic feet, as compared with 79,906,919,000 cubic feet, valued at $15,166,434 in

1908, or 18.98 cents per thousand cubic feet. It will be seen that nearly one-half of the gas consumed in this State is piped into it.

The table giving distribution of gas in 1909 shows that the quantity and value of gas consumed in Ohio for domestic purposes was greater than that of any other State. The estimated quantity consumed was 50,356,496,000 cubic feet, valued at $13,503,091, as against 43,848,494,000 cubic feet, valued at $10,999,302, in 1908, the number of domestic consumers increasing from 427,276 in 1908 to 450,973 in 1909. At the same time there was a substantial gain in industrial consumption, the quantity consumed for industrial purposes in 1909 being 47,510,684,000 cubic feet, valued at $5,381,221, as against 36,058,425,000 cubic feet, valued at $4,167,232, in 1908, the number of industrial consumers increasing from 3,621 in 1908 to 5,260 in 1909. The report shows that Ohio ranked second to Pennsylvania in the value received for gas consumed in the State for industrial purposes in 1909.

The estimated quantity of gas produced from oil wells in this State and consumed in the field in 1909, as reported by 619 oil producers, amounted to 2,497,922,000 cubic feet, valued at $279,335.

The number of wells drilled by gas producers in Ohio in 1909 was 697, of which 548 were gas and 149 were dry holes, making the total number of gas wells at the close of the year 4,042. These figures include 1,457 shallow wells located in Ashtabula, Cuyahoga, Lake, Lorain, and Huron counties, whose product is used principally by the owners, and few of which will supply more than one or two families with gas.

The lowest price received for gas in Ohio in 1909 was 3 cents per thousand cubic feet for gas sold at the well for manufacturing, and the highest price was 50 cents for gas supplied for domestic consumption; the average price for the year was 19.3 cents.

Record of natural gas industry in Ohio, 1897–1909.

Year.	Gas produced.		Gas consumed.			Wells.		
	Number of producers.	Value.	Number of consumers.		Value.	Drilled.		Productive Dec. 31.
			Domestic.	Industrial.		Gas.	Dry.	
1897	157	$1,171,777	a 85,368	183	$1,506,454	88	51	729
1898	237	1,488,308	a 68,211	349	2,250,706	120	12	806
1899	359	1,866,271	a 77,787	691	3,207,286	134	17	929
1900	281	2,178,234	a 135,743	1,092	3,823,209	97	19	990
1901	305	2,147,215	a 149,709	949	4,119,059	113	35	1,099
1902	451	2,355,458	120,127	786	4,785,766	266	40	1,343
1903	515	4,479,040	197,710	1,786	7,200,867	290	62	1,523
1904	453	5,315,564	232,557	1,136	9,393,843	334	49	1,661
1905	425	5,721,462	274,585	2,955	10,396,633	342	58	1,705
1906	409	7,145,809	310,175	3,316	12,652,520	337	51	b 1,977
1907	468	8,718,562	380,489	5,476	15,227,780	431	90	2,942
1908	c 970	8,244,835	427,276	3,621	15,166,434	398	124	d 3,691
1909	c 1,534	9,966,938	450,973	5,260	18,884,312	548	149	d 4,042

a Number of fires supplied.
b Exclusive of complete report of shallow wells.
c Includes 735 producers in Ashtabula, Lake, Lorain, and Cuyahoga counties having shallow wells for their own domestic purposes in 1908, and 1,239 in 1909.
d Includes 901 shallow wells located in Ashtabula, Huron, Lake, Lorain, and Cuyahoga counties in 1908 and 1,457 in 1909.

Depth and gas pressure of wells in Ohio, 1906 to 1909, by counties.

County.	Depth, in feet.	Pressure, in pounds.			
		1906.	1907.	1908.	1909.
Allen	1,200-1,300	25- 100	200	....	....
Ashtabula	500-2,030	....	....	3- 300	5- 300
Athens	450-1,500	50- 350	100	30- 250	160- 280
Auglaize	1,110-1,225	....	5- 250	5- 225	....
Belmont	1,100-1,824	150	200- 275	5- 100	200- 300
Carroll	950-1,434	....	200- 375	200- 350	165- 300
Columbiana	575- 900	90- 225	70- 240	30- 275	50- 287
Cuyahoga	500-1,300	....	....	90	2- 100
Darke	850-1,300	....	75- 103	30	5- 25
Fairfield	1,900-2,600	15- 300	40- 130	5- 150	60- 500
Guernsey	1,009-1,311	250	400	300- 450	80- 400
Hancock	1,100-1,400	2- 250	85	3- 5	2- 70
Hardin	1,260-1,460	250	....	16- 150	25- 40
Harrison	703-1,630	100- 300	40- 200	5- 125	5- 400
Hocking	2,300-3,300	500- 600	....	....	800- 850
Holmes	600-1,000	210	215	180- 205	225
Jefferson	600-2,026	200- 300	240	150- 495	40- 230
Knox	590-3,000	50- 940	110- 400	140- 900	25- 400
Lake	500-1,560	....	....	100	1- 100
Licking	2,100-2,900	300- 500	200- 750	100- 730	100- 750
Logan	1,385-1,460	25	40	....	130- 280
Lorain	338-2,590	....	....	0- 120	0- 840
Lucas	1,165-1,550	0- 90	1- 90	1- 80	8- 30
Medina	250-1,300	....	....	20- 75	10- 40
Mercer	1,096-1,400	20- 43	2- 40	2- 250	4- 210
Monroe	650-2,400	136	400	200- 500	25- 500
Morgan	250-1,650	30- 500	15- 500	20- 450	10- 400
Muskingum	800-3,350	....	400- 425	350- 400	1,000-1,100
Noble	484-2,000	....	....	550	150- 700
Ottawa	1,250-1,600	50- 420	50- 420	20- 400	100- 350
Perry	1,200-3,448	....	350- 700	75- 85	50- 900
Richland	1,950-2,650	1,000-1,260	1,100	500-1,000	450
Sandusky	470-1,400	30- 150	30- 75	20- 200	40- 160
Seneca	370-1,760	....	15- 140	2- 150	50- 175
Trumbull	370- 388	....	....	75	....
Van Wert	1,200-1,285	75- 200	....	175	35
Vinton and Jackson	520- 800	....	300	275- 325	250
Warren	275-1,000	....	....	40- 50	....
Washington	700-2,600	80- 640	75- 350	15- 550	15- 450
Wood	1,175-1,500	10- 60	20	....	....

INDIANA.

The value of the natural gas produced in Indiana in 1909 was $1,616,903, as compared with $1,312,507 in 1908, an increase of $304,396. This increase was not the direct result of an increased gas production, but the result of a greater number of returns received from producers through the personal canvass of the census agents. Since the last report was made many gas wells in the State have been abandoned by the gas companies and have been purchased by or turned over to the farmers upon whose lands they are located; hence reports were received from 823 gas producers in 1908, although the gas producers numbered 1,010 in 1909 and although the number of wells declined from 3,223 at the close of 1908 to 2,938 at the close of 1909.

In the latter part of 1908 a few wells were drilled in Pike County, which opened a new gas territory in this State. Upon further development in 1909 a number of wells were drilled, which, at a depth of from 1,000 to 1,400 feet, are producing considerable gas with a pressure of 300 to 500 pounds. Consumers in Oakland City were supplied with gas from this field in 1909, and Petersburg has been piped to be supplied with gas from the same field.

The greater part of the gas produced in Indiana is utilized for domestic purposes, the quantity consumed for industrial uses being less and less each year. Most of the gas consumed industrially is used for power and not for manufacturing. The total value of the gas consumed for domestic purposes in 1909 was $1,407,313, an average price of 30.2 cents per thousand cubic feet, as compared with $1,108,001, worth 28 cents per thousand cubic feet, in 1908, which shows that the price of gas is advancing in this State.

From reports received from 107 oil producers in Indiana the estimated quantity of gas produced from oil wells and consumed for field work in 1909 was 294,214,000 cubic feet, valued at $45,126. Many oil wells have been abandoned from year to year in this State for want of gas to operate them. The abandonment of these wells began in 1905, when it became necessary to look for fuel other than gas for pumping. Since this time it is reported that over 7,000 wells have been abandoned in the Indiana oil fields. As it may be of interest to know the number of oil wells abandoned monthly since June, 1905, the following table is given:

Number of oil wells abandoned in the Indiana oil fields from June, 1905, to November, 1909, by months.

Month.	1905.	1906.	1907.	1908.	1909.
January	....	54	45	75	149
February	....	74	83	59	108
March	....	27	49	129	237
April	....	47	129	198	98
May	....	100	194	358	204
June	28	82	143	207	347
July	53	50	111	191	157
August	54	147	170	228	322
September	19	87	157	195	267
October	158	139	181	144	201
November	53	139	177	155	172
December	66	117	62	220	....
Total	431	1,063	1,501	2,159	2,262

During the year 260 wells were completed by gas producers in Indiana, of which 190 were productive of gas and 70 were dry holes, the total number of gas wells at the close of the year 1909 being 2,938.

The statistics of the natural-gas industry in Indiana are given in the following table:

Record of natural gas industry in Indiana, 1897–1909.

Year.	Gas produced.		Gas consumed.			Wells.		
	Number of producers.	Value.	Number of consumers.		Value.	Drilled.		Productive Dec. 31.
			Domestic.	Industrial.		Gas.	Dry.	
1897	452	$5,009,208	a 214,750	935	$3,945,307	419	66	2,881
1898	533	5,060,969	a 173,454	1,867	4,682,401	706	111	3,325
1899	571	6,680,370	a 181,440	1,741	b 5,833,370	838	109	3,909
1900	670	7,254,539	a 181,751	2,751	b 6,412,307	861	156	4,546
1901	656	6,954,566	a 153,869	2,570	b 6,276,119	985	208	4,572
1902	929	7,081,344	101,481	3,282	b 6,710,080	1,331	205	5,820
1903	924	6,098,364	90,118	1,020	b 5,915,367	895	242	5,514
1904	846	4,342,409	84,862	390	b 4,282,409	706	153	4,684
1905	740	3,094,134	63,194	231	b 3,056,634	252	74	3,650
1906	578	1,750,715	47,368	156	b 1,750,755	159	46	3,523
1907	687	1,572,605	46,210	218	b 1,570,605	185	56	3,386
1908	823	1,312,507	42,054	216	b 1,312,507	187	41	3,223
1909	1,010	1,616,903	40,565	369	b 1,616,903	190	70	2,938

a Number of fires supplied. b Includes value of gas consumed in Chicago, Ill.

Depth and gas pressure of wells in Indiana, 1906 to 1909, by counties.

County.	Depth, in feet.	Pressure, in pounds.			
		1906.	1907.	1908.	1909.
Adams	1,000-1,050				250
Bartholomew	864- 990	25-150	5- 150	100-150	50-175
Blackford	850-1,080	1- 5	1- 65	2- 60	1- 25
Clark	128- 244			10- 27	
Daviess, Martin	400- 600	4- 15	8- 25	5- 50	0- 20
Decatur	725-1,000	30-340	15- 335	10-335	0-325
Delaware	728-1,200	1- 35	1- 40	1- 75	1- 55
Grant	830-1,100	[a] 0- 15	[a] 0-[b] 240	45	2- 45
Hamilton	800-1,200	10-200	10- 175	10-190	5-185
Hancock	700-1,100	5-200	5- 140	5-250	0-100
Harrison	320- 404	30	60	40	
Henry	800-1,100	10-200	15- 120	5-270	5-100
Howard	860-1,100	20-200	25- 250	3-240	0-200
Jay	900-1,417	190	160	60	0- 50
Jefferson	1,360			8- 10	
Madison	800-1,100	½- 50	1- 200	1-150	0-200
Miami	900-1,000	70-100	20- 60	20-100	0- 10
Marion, Ripley	950-1,000		60- 190		35
Pike	1,000-1,400			250-525	300-550
Randolph	900-1,300	25-275	5- 260	1-220	0-175
Rush	780-1,035	40-350	25- 350	10-350	9-375
Shelby	750-1,000	60-330	45- 350	25-330	10-310
Spencer	950-1,000				Less than 285-390.
Sullivan	721- 750		295	295	(Spencer and Sullivan: Less than 285-390.)
Tipton	750-1,100	45-215	40- 200	10-180	18-180
Wayne	800-1,150	70- 75	50- 80	50-250	20-300

[a] Run on vacuum. [b] New.

ILLINOIS.

The natural-gas industry of Illinois is of small importance as compared with its petroleum industry, this State ranking second in the value of petroleum production in 1909 and eighth in the value of gas production.

The total quantity of gas produced in Illinois in 1909 was 8,472,860,000 cubic feet, valued at $644,401, or 7.61 cents per thousand cubic feet, as against 4,978,879,000 cubic feet, valued at $446,077, or 8.96 cents per thousand cubic feet in 1908, a gain of 3,493,981,000 cubic feet in quantity and of $198,324 in value. This increase was largely due to the increase in industrial consumption. The domestic consumption increased from 1,050,252,000 cubic feet, valued at $194,859, in 1908, to 1,270,421,000 cubic feet, valued at $248,318, in 1909, while the industrial consumption rose from 3,928,627,000 cubic feet, valued at $251,218, in 1908, to 7,202,439,000 cubic feet, valued at $396,083, in 1909. Referring to the table of distribution of industrial consumption, it will be noted that a very small quantity of the gas produced in the State was consumed in manufacturing, the larger part being utilized for developing power for operating and drilling in the oil fields of the State. From reports received from 209 oil producers it was learned that 2,859,405,000 cubic feet of gas, valued at $121,661, was produced from oil wells alone and consumed in the field, not including gas produced from gas wells and consumed for field purposes.

During 1909 the following named places in Illinois were supplied with gas from oil and gas wells in Clark, Crawford, Cumberland, McLean, and Lawrence counties: Casey, Olney, Robinson, Oblong, Palestine, Stoy, Duncansville, New Hebron, Hutsonville, Annapolis, Porterville, Marshall, Martinsville, Lawrenceville, Pinkstaff, Birds, Flatrock, and Heyworth; in addition, Vincennes, Ind., was supplied with gas from Crawford County, Ill.

The price of gas per thousand cubic feet in Illinois in 1909 ranged from 2 cents, the lowest estimated price of gas consumed for industrial use, to 25 cents, the highest price paid for gas supplied for domestic use, the average price for the year being 7.61 cents for all gas consumed.

In the year 1909 a total of 67 wells were drilled by gas producers in Illinois, of which 56 were productive of gas and 11 were dry holes. The number of gas wells abandoned in 1909 was 42, and the total number of gas wells at the close of the year was 414, this number including 190 shallow wells reported by 161 producers in Bureau, Champaign, Dewitt, Edgar, Lee, Logan, and Pike counties. Few of these wells produced more than enough gas for the use of one family.

Record of natural gas industry in Illinois, 1906–1909.

Year.	Gas produced.		Gas consumed.			Wells.		
	Number of producers.	Value.	Number of consumers.		Value.	Drilled.		Productive Dec. 31.
			Domestic.	Industrial.		Gas.	Dry.	
1906	66	$87,211	1,429	2	$87,211	......	......	200
1907	128	143,577	2,126	61	143,577	94	41	283
1908	185	446,077	[a] 7,377	[a] 204	[a] 446,077	121	42	400
1909	194	644,401	[a] 8,458	[a] 518	[a] 644,401	56	11	414

[a] Includes number of consumers and value of gas consumed in Vincennes, Ind.

Depth and gas pressure of wells in Illinois in 1908 and 1909, by counties.

County.	Depth, in feet.	Pressure, in pounds.	
		1908.	1909.
Bureau	105- 330	0- 30	0- 23
Clark	250- 550	65-100	38-100
Crawford	500-1,550	25-400	45-275
Cumberland	500- 575	15- 35	40
Lawrence	1,400-1,652	500-600	200-580
Pike	115- 342	3- 10	3- 7

KANSAS.

As a gas-producing State Kansas took third rank in 1909. The total quantity of gas produced from wells in this State aggregated 75,074,416,000 cubic feet, valued at $8,293,846, in 1909, as compared with 80,740,264,000 cubic feet, valued at $7,691,587, in 1908, which shows that the value of the natural gas produced in 1909 exceeded that of 1908, although there was a decline in the quantity of gas produced. The table, giving the distribution of gas, shows that this reduction was in the quantity of gas consumed in manufacturing, and as much of this gas was sold and used without measurement it must be said that the figures given are only approximate.

The total quantity of gas consumed in Kansas for domestic purposes in 1909 was 23,863,178,000 cubic feet, valued at $4,923,702, an average price of 20.6 cents per thousand cubic feet, as compared with 23,140,099,000 cubic feet, valued at $4,647,157, an average price of 20.1 cents per thousand cubic feet, in 1908, a gain in 1909 in both quantity and value. It will also be noted that the number of domestic consumers supplied increased from 168,855 in 1908 to 182,657 in 1909. The quantity of gas consumed in the industries amounted to 54,024,280,000 cubic feet, valued at $3,432,374, in 1909, as compared with 57,600,165,000 cubic feet, valued at $3,044,430, in 1908. As the Kansas Natural Gas Company is the only producer which pipes gas from Kansas to Missouri, the figures reported by this company giving consumption of gas in Missouri are included with the figures given for Kansas.

Although the report shows a decline in industrial consumption the State of Kansas occupies the third place in the quantity of gas consumed for industrial purposes in 1909. Large quantities of gas are consumed by the zinc-smelting, cement, brick, and glass industries in Kansas. In 1909 it is estimated that there was consumed by smelters a total of 13,992,666,000 cubic feet of gas, valued at $516,621; in cement works, 11,808,344,000 cubic feet, valued at $451,241; and in brick and glass works, 4,651,749,000 cubic feet, valued at $178,527, a total of 30,452,759,000 cubic feet of gas, valued at $1,146,389, for these four industries alone. The estimates given of the value of gas per thousand cubic feet consumed at zinc-smelting and cement plants in 1909 varied from 2 to 5 cents and at brick works from 2 to 6 cents. The average price per thousand cubic feet of all gas consumed in the State in the industries was 6.4 cents in 1909, as compared with 5.3 cents in 1908, an increase of 1.1 cents.

Very little gas is produced from the oil wells of Kansas. From reports received from oil producers it is estimated that 64,234,000 cubic feet of gas were produced in 1909 from oil wells and consumed in field work; its value was $5,222.

Drilling was quite active in the gas fields of this State and resulted in bringing in 452 gas wells out of a total of 666 wells completed, making the total number of gas wells at the close of the year 2,138. So far as learned no new gas fields were discovered in 1909.

Record of natural-gas industry in Kansas, 1897–1909.

Year.	Gas produced.		Gas consumed.			Wells.		
	Number of producers.	Value.	Number of consumers.		Value.	Drilled.		Productive Dec. 31.
			Domestic.	Industrial.		Gas.	Dry.	
1897	10	$105,700	a 3,956	20	$105,700	16	8	90
1898	29	174,640	a 6,186	44	174,640	34	18	121
1899	31	332,592	a 10,071	71	332,592	44	22	160
1900	32	356,900	a 9,703	65	356,900	54	15	209
1901	48	659,173	a 10,227	72	659,173	71	35	276
1902	80	824,431	13,488	91	824,431	144	63	404
1903	120	1,123,849	15,918	143	1,123,849	295	66	666
1904	190	1,517,643	27,204	298	1,517,643	378	135	1,029
1905	171	2,261,836	46,852	601	2,265,945	340	157	1,142
1906	130	4,010,986	79,270	990	b 4,023,566	331	99	1,495
1907	196	6,198,583	149,327	1,605	b 6,208,862	361	163	1,760
1908	212	7,691,587	168,855	1,162	b 7,691,587	403	208	1,917
1909	199	8,293,846	182,657	1,160	b 8,356,076	452	214	2,138

a Number of fires supplied. b Includes gas taken from Kansas and consumed in Missouri.

Depth and gas pressure of wells in Kansas, 1906 to 1909, by counties.

County.	Depth, in feet.	Pressure, in pounds.			
		1906.	1907.	1908.	1909.
Allen	600-1,300	40-400	10-300	5-300	5-300
Anderson	230- 765	65-240	43-200	65-237	65-200
Bourbon	200- 710	5- 60	50	50	75
Chase	150- 580		48-100	6-150	17-300
Crawford, Cowley	150- 800	30-100	25-150	20- 26	55- 80
Chautauqua	325-1,300	75-320	50-280	50-260	60-500
Douglas, Johnson	335- 675	150-180	60-230	5-170	40-180
Elk	500-1,278	290	10-300	100-215	40-200
Butler, Greenwood, Woodson	365-1,450	80-390	75-450	40-640	40-500
Labette	450-1,000	250-285	80-200	80-208	60-125
Linn	200- 600	25-185	9-175	10-175	10-150
Franklin, Miami	160- 750	70- 75	20-225	20-260	20-200
Montgomery	258-1,600	100-650	25-530	40-530	10-350
Neosho	490-1,200	90-300	40-225	50-250	25-350
Wilson	670-1,300	135-400	70-395	50-395	25-400
Wyandotte	271- 635		175	160-198	150-250

MISSOURI.

The natural-gas industry of Missouri is of little importance. There has been considerable drilling from year to year in search of oil and gas, but the results have not been satisfactory, no large producing wells having been discovered. The gas wells of the State are located in Bates, Cass, Clay, and Jackson counties, and the wells range in depth from 105 to 500 feet. The statistics of gas production for 1909 show a falling off as compared with 1908, the quantity of gas produced in 1909 being 49,117,000 cubic feet, valued at $10,025, as against 152,280,000 cubic feet, valued at $22,592, in 1908. The reports show that the greatest decline was in industrial consumption. Domestic consumers in Rich Hill were supplied for the first time in 1909 with gas from wells drilled in Bates County in 1908 and 1909. The towns of Missouri in which domestic consumers are supplied with gas produced in the State are Hume, Rich Hill, Belton, Cleveland, and West Line. The number of domestic consumers supplied with gas produced in the State in 1909 was 401.

A large quantity of gas was piped from the gas fields of Kansas and supplied to domestic and industrial consumers in the State of Missouri in 1909, and steps are being taken to supply consumers in Missouri with gas from Oklahoma also in the near future.

OKLAHOMA.

Since the drilling in of the Caney well in February, 1906, the natural-gas industry of Oklahoma has continued to increase with great rapidity, the only drawback being lack of adequate market for the output. This well, which was one of the most spectacular gas wells ever completed, was drilled in Cherokee Nation. It is 1,500 feet deep and is located 4 miles south of Caney, Kans., 1 mile from the State line.

The statistics of the natural-gas industry in Oklahoma show that the gain in gas production in this State in 1909 as compared with 1908 was greater than that in any other State, the quantity of gas produced in 1909 being 28,036,976,000 cubic feet, valued at $1,806,193, an increase of more than 100 per cent in both quantity and value over 1908, when the production was 11,924,574,000 cubic feet of gas, valued at $860,159. This increase was due in a great measure to the greater activity in the development of the gas fields after the annulment, early in 1909, of the State law prohibiting the pipage of gas from the State. Although only a small quantity of gas is now piped from the State, projects are under way for the extension of pipe lines to supply consumers outside of the State, one of these being the construction of the 16-inch line by the Quapaw Gas Company from Washington County, Okla., to Joplin, Mo., to supply the lead, zinc, and other industries of that State. It is reported that other lines will be laid to Kansas to supply the needs of consumers in that State, particularly the smelters, which require large quantities of gas.

The principal gas-producing districts of Oklahoma are the Hogshooter, the Collinsville, and the Copan. The Hogshooter, which includes the wells in Washington County, developed some wonderful wells and was the most prolific gas district of the State in 1909. It is from this district that the smelters at Bartlesville and the cement plant at Dewey draw their supply of gas. Natural gas is utilized by domestic and industrial consumers in many towns near the locality in which it is produced. The following list indicates towns and sources of supply: Ardmore, from wells in Carter County; Lawton, from Comanche County; Mounds, Bristow, Sapulpa, and Skiatook, from Creek County; Blackwell and Ponca City, from Kay County; Gotebo, from Kiowa County; Vinita, from Nowata County; Beggs, Morris, Okmulgee, and Henryetta, from Okmulgee County; Tulsa, Redfork, Owasso, Glenpool, and Bixby, from Tulsa County; Pawhuska, Ochelata, and Bigheart, from Osage County; Cleveland and Hallett, from Pawnee County; Chelsea, Oologah, and Collinsville, from Rogers County; Coweta, from Wagoner County; and Bartlesville, Muskogee, Claremore, Wagoner, Ramona, Inola, Oglesby, Oklahoma City, Shawnee, Guthrie, Chandler, Stroud, Wellston, Davenport, Luther, Edmond, Meeker, and Depew, from Washington County. Several of these towns were supplied with gas for the first time in 1909.

The quantity of gas consumed in this State for domestic use in 1909 was 4,393,368,000 cubic feet, valued at $721,477, an average of 16.4 cents per thousand cubic feet; the domestic consumption in 1908 was 2,562,201,000 cubic feet, valued at $451,906, an average price of 17.6 cents per thousand cubic feet. The quantity of gas consumed in industrial use in 1909 was 20,830,566,000 cubic feet, valued at $1,022,486, an average of 4.9 cents per thousand cubic feet; the industrial consumption in 1908 was 9,362,373,000 cubic feet, valued at $408,253, an average price of 4.4 cents per thousand cubic feet. The industrial consumption in 1909 included not less than 4,237,075,000 cubic feet of gas, valued at $97,035, consumed by zinc smelting, cement, and brick industries alone; also 3,478,443,000 cubic feet of gas, valued at $149,864, produced from oil wells, as reported by 316 oil producers and consumed in field work, exclusive of gas produced from gas wells and consumed in drilling and operating.

The lowest price reported for gas sold in Oklahoma in 1909 was 1 cent per thousand cubic feet for gas at the well; the highest price was 47 cents per thousand cubic feet for gas sold for domestic use, the average price received for all gas consumed in the State being 6.91 cents per thousand cubic feet.

During the year 1909 a total of 132 wells were completed by the gas producers of Oklahoma, of which 97 were productive of gas and 35 were dry holes. The number of productive gas wells at the close of 1909 was 415, several of which were closed, awaiting a market for their product.

Record of natural-gas industry in Oklahoma, 1906–1909.

Year.	Gas produced.		Gas consumed.			Wells.		
	Number of producers.	Value.	Number of consumers.		Value.	Drilled.		Productive Dec. 31.
			Domestic.	Industrial.		Gas.	Dry.	
1906	50	$259,862	8,391	202	$247,282	81	33	239
1907	107	417,221	11,038	277	406,942	99	41	[a] 344
1908	115	860,159	17,567	356	860,159	73	40	[b] 374
1909	131	1,806,193	32,907	1,527	1,743,963	97	35	415

[a] Includes 87 wells "shut in" in 1907. [b] Includes 100 wells "shut in" in 1908.

Depth and gas pressure of wells in Oklahoma in 1909, by counties.

County.	Depth, in feet.	Pressure, in pounds.	
		1908.	1909.
Carter	700– 900	190–200	50–350
Cherokee	600– 650		
Comanche	380– 400		
Creek	895–2,500	60–900	50–900
Kay	500– 997	75–481	60–385
Kiowa	380– 640	50–150	....
Muskogee	1,055–1,865	470–650	130–160
Nowata	500–1,700	100–450	120–500
Okmulgee	760–2,090	300–800	150–700
Osage	1,500–2,010	300–850	300–850
Pawnee	1,200–1,698	200–400	160–260
Rogers	380–1,250	110–320	50–550
Tulsa	580–1,742	50–700	50–700
Wagoner	750–1,692	350–600	210–600
Washington	453–2,260	40–700	60–800

ALABAMA.

At the close of 1909 there were in the State of Alabama 16 gas wells, only 8 of which were in service. The only company in the State which supplied domestic consumers with gas in 1909 was the New York-Alabama Oil Company, which has been supplying consumers in Huntsville and West Huntsville with gas from wells in Madison County, consequently the figures of gas production and value for this State have been included with those of Louisiana and Texas.

During 1909 considerable excitement was created in the State by the discovery of gas in Fayette County, where four wells, large in volume and high in pressure, were drilled by the Providence Oil and Gas Company to a depth varying from 950 to 1,413 feet. The field appears very promising. The measures are Carboniferous. It is estimated by the company that the deepest well will flow 4,000,000 cubic feet of gas daily and that it has a rock pressure of 600 pounds. None of this gas has been sold, but some has been used for fuel and light in the camp. Before a depth of 1,400 feet was reached six oil-bearing sands were passed through, none in paying quantities, but some with a very strong odor of petroleum. Four other wells are in process of drilling by this company and were down 1,100, 1,333, 950, and 150 feet, respectively, at the end of the year, gas being found in all except in the shallow well. It is estimated that the four wells thus far successfully completed and capped probably have a combined capacity of not less than 5,000,000 cubic feet of gas per day, which could be delivered to Birmingham through 80 miles of 6-inch pipe, though a larger pipe (12-inch) would be required for the total needs of the city. An analysis of the gas by the Tennessee Coal, Iron, and Railway Company shows it to be the usual natural gas of the Appalachian region, consisting of over 93.5 per cent methane, with no sulphur. Every effort is being made to determine whether the supply of gas will be sufficient to supply Birmingham. A franchise has been secured at about 45 cents per thousand cubic feet for domestic use and at half this price for industrial use.

ARKANSAS.

So far as could be learned no new gas fields were discovered in Arkansas in 1909, the only productive gas district in the State being located in Sebastian County, where 62 gas wells have been completed. Their product is supplied to domestic and industrial consumers in Fort Smith, Van Buren, Mansfield, and Huntington. Nine wells were drilled in this county in 1909, eight of which were gas wells; the other was a dry hole. One gas well was abandoned.

Two wells drilled in Pulaski County in 1909, one to a depth of 1,400 feet, the other to a depth of 2,000 feet, found only a trace of gas and have been abandoned. Drilling operations near Plummerville, Conway County, have been suspended. A 6-inch well was drilling at Hope, Hempstead County, and a depth of 1,245 feet had been reached in 1909.

The prospects are that natural gas from the Caddo gas field of Louisiana will be supplied to consumers in Little Rock, Hot Springs, and other towns in Arkansas in the near future, the pipe line being under construction.

The figures giving the production and value of natural gas in Arkansas in 1909 have been included with those of Colorado and Wyoming.

LOUISIANA.

As there were but three producers in the State of Louisiana which supplied gas for domestic consumption in 1909 the figures of production for this State have been consolidated with those of Texas and Alabama. The greatest producer in the State is the Caddo Gas and Oil Company, which supplied Blanchard, Mooringsport, Caddo, Rodessa, Oil City, Vivian, Bloomburg, and Ravenna directly, and through the Shreveport Gas, Electric Light, and Power Company supplied Shreveport and Bossier City. This company also supplied gas which was piped out of the State to domestic and manufacturing consumers in Texarkana, Ark., and Texarkana, Marshall, Atlanta, and Queen City, Tex. Belcher and Dixie, La., were also supplied with gas in 1909. The greater portion of the gas consumed in Louisiana in 1909 was used for drilling and operating purposes in the oil and gas fields of the State.

Development of gas territory in this State shows the wonderful capacity and high pressure of the wells and proves it to be the greatest gas-producing section now known in the United States. Enormous quantities of gas have been found from Mooringsport north to Vivian and from west of James Bayou east to Dixie.[a]

Many plans are under way for piping gas from the Caddo field to market. There is under construction by the Arkansas Natural Gas Company a pipe line of large capacity to reach from the Caddo field to Little Rock, Ark., and branch lines will be laid to other towns between the limits of the large main, including Hot Springs, Pine Bluff, Arkadelphia, Hope, Malvern, Prescott, Benton, and other smaller towns. Other companies are planning to supply St. Louis and New Orleans with gas from the Caddo field.

The territory owned and leased by gas companies in this State at the close of 1909 was 312,763 acres. A total of 58 gas wells have been completed, 26 of which were drilled in 1909. The gas wells in the Caddo field range in depth from 800 to 2,313 feet, the pressure varying from 157 to 460 pounds.

An analysis of Caddo gas, made by Prof. C. F. Phillips, is as follows:

Analysis of natural gas from Caddo field, Louisiana.

Methane	95.00
Nitrogen	2.56
Carbon dioxide	2.34
Hydrogen	.0
Carbon monoxide	.0
Ethylene	.0
Sulphide	.01

TEXAS.

The year 1909 was one of great activity in natural-gas interests in Texas. The Lone Star Gas Company, the principal gas producer in the Clay County field, began business in June, 1909, supplying gas from its wells to the Clayco Oil and Pipe Line Company, which distributed the gas to domestic and industrial consumers in the towns of Henrietta, Petrolia, and Wichita Falls. There was in the Clay County field a total of 10 gas wells at the close of 1909, of which 6 were completed in 1909. The wells varied in depth from 1,523 to 1,696 feet and the pressure was as great as 750 pounds. Considerable gas was consumed in the Clay County field for development and operation in 1909. Preparations were in progress to pipe gas from this field to Fort Worth and Dallas.

The second gas field of importance in Texas is in Navarro County, which in 1909 had several gas wells ranging in depth from 832 to 1,200 feet with a pressure of 200 to 225 pounds. The gas from these wells was supplied to consumers in Corsicana.

Considerable gas was produced from oil wells in Navarro, Hardin, and Harris counties and used for field work in 1909. Other counties in Texas in which gas wells have been found are Bexar, Brazoria, Goliad, Coleman, Palo Pinto, and Webb.

[a] For more complete information concerning the occurrence of oil and gas in Louisiana see Bull. U. S. Geol. Survey No. 429, 1910, 192 pp.

As there were but three gas companies supplying consumers with gas in Texas in 1909, the statistics of production of gas are included with those of Alabama and Louisiana.

A large quantity of gas, produced from wells in the Caddo field, Louisiana, was piped into Texas in 1909 and supplied to domestic and industrial consumers in Texarkana, Marshall, Atlanta, and Queen City.

SOUTH DAKOTA.

The report shows a reduction in the value of the gas consumed in this State in 1909, the value being $16,164 in 1909 and $24,400 in 1908. All the gas consumed in the State was produced from artesian wells located in Hughes, Lyman, Stanley, Sully, and Walworth counties. At the close of 1909 the number of artesian wells from which gas was used in each county of this State was as follows: Six in Hughes, 3 in Lyman, 11 in Stanley, 15 in Sully, and 2 in Walworth. Of these wells 4 were drilled in 1909—2 in Lyman, 1 in Sully, and 1 in Walworth. The well drilled at Akaska, Walworth County, was completed at a depth of 1,700 feet; it was 4½ inches in diameter at top and 3 inches at bottom, and produced about 15,000 cubic feet of gas daily, only sufficient for lighting, heating, and cooking in three or four houses. Gas from the artesian wells was largely used for lighting and heating in the houses on the ranches in these counties where the wells are located. The towns which were partly supplied with gas were Pierre and Fort Pierre. The gas consumed for industrial purposes in the State was used to operate gas engines in the towns supplied.

COLORADO.

There has been no change in the natural-gas situation in Colorado since the report for 1908. The gas consumed in 1909 for domestic use in this State was principally from one well located near Boulder, a small quantity of gas being also supplied for domestic use from one well in Las Animas County and from oil wells in the Florence oil field, Fremont County. Gas supplied for industrial purposes in this State in 1909 was produced from oil wells in the Boulder and the Florence fields and was consumed for development and operation in these fields.

The statistics of the gas consumed in this State in 1909 have been included with those of Arkansas and Wyoming.

WYOMING.

The productive natural-gas districts of Wyoming are located in Bighorn and Converse counties, the consumption of gas having been greater in 1909 than in any previous year. One of the chief events in 1909 in the natural-gas industry in this State was the introduction of gas into the towns of Basin and Graybull for domestic and industrial consumption from wells in Bighorn County controlled by the Big Horn Oil and Gas Company. These wells are drilled to a depth of 900 to 1,100 feet. The Montana and Wyoming Oil Company operating in this county produced from oil wells considerable gas, which was used for power. Three gas wells located in the same county were plugged during 1909.

A small quantity of gas was produced from gas wells located in Converse County and sold and consumed in 1909.

There were at the close of 1909 a total of 12 gas wells in Wyoming, of which 3 were drilled in 1909. Seven wells are located in Bighorn County and 5 in Converse County.

The statistics of gas production in Wyoming in 1909 have been included with those of Arkansas and Colorado.

CALIFORNIA.

Much interest was created in the natural-gas industry of California in 1909 by the drilling in of two very fine gas wells in different parts of the State. One well with a pressure of 450 pounds was drilled by the Standard Oil Company in Kern County, the other with a pressure of 250 pounds was drilled by the Ramona Oil Company in Sonoma County.

The value of the gas consumed in the State in 1909 was $446,933 as compared with $307,652 in 1908, an increase of $139,281. The value of the gas used for domestic consumption amounted to $203,156, the greater part of which was consumed in the cities of Stockton and Sacramento; this gas was supplied from wells in San Joaquin and Sacramento counties. The towns of Oxnard, Santa Paula, Ventura, Hueneme, and El Rio were supplied with gas from wells in Ventura County. The towns of Fairfield, Suisun City, and Cement were supplied with gas from Solano County. Santa Maria, Carpinteria, and Orcutt were supplied with gas from the Santa Maria oil fields. A large quantity of gas was consumed in the State for industrial purposes in 1909, the value being estimated at $243,777. Part of this gas was used in machine shops and power plants in the towns supplied, besides large quantities that were supplied from oil wells to boilers and engines and pumping stations in the oil fields.

Several projects are under way for supplying gas to towns in close proximity to the oil fields where large quantities of unused gas are produced. One plan is to pipe gas from the Santa Maria oil field to the towns of San Luis Obispo and Santa Barbara; another is to pipe gas to Bakersfield from the prolific gas belt of Kern County.

At the close of 1909 there was a total of 64 gas wells in California, of which 7 were drilled in 1909. Five gas wells were abandoned in 1909.

NORTH DAKOTA.

The most important event in the history of the natural-gas industry of North Dakota in 1909 was the piping of gas from wells in Bottineau County to supply domestic consumers in the town of Westhope. At the close of the year Lansford had also been piped, and domestic consumers were being supplied with gas from this field. Gas was also used in the field for drilling purposes. The use of natural gas for fuel will be a great boon to the people of this locality on account of the high price of coal. There were in Bottineau County at the close of 1909 a total of 12 gas wells, 6 of which were completed in 1909.

Some gas was produced from 7 artesian wells located in Lamoure County and was consumed for domestic purposes by the owners of the wells.

The total value of the gas consumed in this State in 1909 was $3,025, as compared with $2,480 in 1908.

OREGON.

Considerable prospecting has been done in Malheur County, but so far has not resulted in finding either oil or gas in commercial quantities. One well was in process of drilling in 1909 and had reached a depth of 3,400 feet.

MICHIGAN.

Michigan appeared for the first time as a gas-producing State in 1909. The gas consumed in this State in 1909 was produced from 4 artesian wells located in Macomb County, the gas being used by the owners of the wells for domestic consumption.

IOWA.

Up to the present time the natural-gas production of this State has scarcely been worthy of mention. What the possibilities are for the future can not be surmised. So far as could be learned no new gas wells were drilled in 1909. Six shallow gas wells have been completed in Louisa County. The gas from one well was used for heat in 1909, the output being supplied to a country schoolhouse; the gas from three other wells was used for lighting the houses of the owners of the wells; two of the wells were closed in.

NEW MEXICO.

Two gas wells have been drilled in Eddy County, N. Mex., the product of which was not utilized in 1909.

TENNESSEE.

The natural-gas situation in Tennessee in 1909 remained the same as in 1908, no new discoveries of gas having been made. Two wells only, 1 in Franklin County and 1 in White County, were in service in 1909, each supplying gas for the use of one family. There are 3 other gas wells in this State, 1 in Franklin County, 1 in Dekalb County, and 1 in White County, all of which were closed in in 1909.

PHILIPPINE ISLANDS.[a]

Much interest was aroused in 1908 by the tapping of small reservoirs of natural gas in the Philippines in the course of drilling for artesian water. Two of these reservoirs have been investigated by members of the scientific staff of the Bureau of Science. It was found that only a small pocket of gas had been penetrated in each well and that the supply was exceedingly small and intermittent. Mr. Rivers, a well driller in the employ of the civil government, gave the following notes:

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[a] From advance sheets of "The nonmetallic minerals of the Philippines," by Warren D. Smith, chief of the division of mines, Bureau of Science, Manila.

Notes on natural gas in the Philippines.

Locality.	Struck gas at—	Quantity.	Struck water at—	Quantity per minute.
Macabebe:	*Feet.*		*Feet.*	*Gallons.*
Pampanga, Luzon	120	Flash	190	75
Manalan:				
Pampanga, Luzon	160	Flash	310	75
Santa Tomas:				
Batangas, Luzon	125	Flame 10 feet high; burned 15 minutes, then extinguished.	220	120
San Jacinto:				
Pangasinan, Luzon	55	Flame 20 feet high; great force.	Well cased and driven deeper; work stopped here.	None.
Lingayan:				
Pangasinan, Luzon	240	Flash		
Bay, Laguna	228	Small intermittent flame.	228	6
Iloilo	155	Flash	Still sinking	

ANALYSES OF NATURAL AND MANUFACTURED GASES.

The great demand for the analytical constants of the several varieties of natural gas has made it advisable to reprint from a previous report the following table of analyses:

Analyses of natural and manufactured gases, their weight and heating quality per 1,000 cubic feet, also their specific gravity.

Constituent.	Average of Pennsylvania and West Virginia natural gas.	Average of Ohio and Indiana natural gas.	Average of Kansas gas.	Average of coal gas.	Average of water gas.	Average of producer gas from bituminous coal.
Marsh gas, CH_4	80.85	93.60	93.65	40.00	2.00	2.05
Other hydrocarbons	14.00	.30	.25	4.00	.00	.04
Nitrogen	4.60	3.60	4.80	2.05	2.00	56.26
Carbonic acid, CO_2	.05	.20	.30	.45	4.00	2.60
Carbonic oxide, CO	.40	.50	1.00	6.00	45.50	27.00
Hydrogen	.10	1.50	.00	46.00	45.00	12.00
Hydrogen sulphide	.00	.15	.00	.00	.00	.00
Oxygen	Trace.	.15	.00	1.50	1.50	.05
Total	100.00	100.00	100.00	100.00	100.00	100.00
Pounds in 1,000 cubic feet [a]	47.50	48.50	49.00	33.00	45.60	75.00
Specific gravity, air being 1	.624	.637	.645	.435	.600	.985
B. T. U. per 1,000 cubic feet [b]	1,145,000	1,095,000	1,100,000	755,000	350,000	155,000

[a] 1,000 cubic feet of air at an atmospheric pressure of 14.7 pounds and at a temperature of 62° F., weighs 76.1 pounds and is a mechanical mixture of 23 parts of oxygen and 77 parts of nitrogen, by weight.

[b] B. T. U.—British thermal unit, which indicates the heat necessary to raise 1 pound of pure water at 39° F. 1 degree.

IMPORTS.

The imports of natural gas for consumption during the last six years have been as follows:

Value of natural gas imported for consumption, 1904–1909.

1904	$34,828	1907	$32,107
1905	49,237	1908	22,003
1906	36,906	1909	6,060

No exports of natural gas during 1907, 1908, and 1909 were reported.

NATURAL GAS IN FOREIGN COUNTRIES.

CANADA.

The report of the Canada department of mines states that natural gas is produced in the Provinces of Ontario and Alberta, the production in the respective provinces ranking in the order named. The production of natural gas is greatly on the increase. In 1909 the returns received show a total production valued at $1,207,029, as compared with $1,012,660 in 1908, and $815,032 in 1907. The following table gives the value of natural gas produced in Canada each year since 1892:

Value of natural gas produced in Canada, 1892–1909.

Year.	Value.	Year.	Value.	Year.	Value.
1892	$150,000	1898	$322,123	1904	$328,376
1893	376,233	1899	387,271	1905	379,561
1894	313,754	1900	417,094	1906	583,523
1895	423,032	1901	339,476	1907	815,032
1896	276,301	1902	195,992	1908	1,012,660
1897	325,873	1903	202,210	1909	1,207,029

Ontario.—The Nineteenth Annual Report of the Bureau of Mines, Toronto, states that, while the production of crude petroleum in Ontario has been falling off, the receipts from natural gas sold have been increasing. The total value of the gas sold in Ontario in 1909 was $1,188,179, an increase over the yield of 1908 of $199,563, and the largest output yet recorded. The sales of gas from the Ontario fields constituted more than 98 per cent of the total production of Canada in 1909.

The natural gas comes from three fields, namely, Welland County, Haldimand and Norfolk Counties, and the counties of Essex and Kent. Bruce County also produces some gas. Probably 200,000 people in Ontario are now using natural gas, and extensions of pipe-line systems were in progress in 1909 which will result in a large increase in this number.

From the Haldimand-Norfolk field, which is the largest producer, gas is piped to Hamilton, Dundas, Galt, Brantford, and other places; the Welland field supplies St. Catherines, Niagara Falls, Bridgeburg, and other towns and villages; and the Essex-Kent field supplies Chatham, Leamington, Blenheim, Windsor, Sarnia, and other towns.

The following statistics regarding the production of natural gas in Ontario, Canada, have been furnished by the Ontario Bureau of Mines, Toronto:

Statistics of natural-gas production in the Province of Ontario, Canada, 1902–1909.

Year.	Producing wells.	Miles of gas pipe.	Workmen employed.	Gas production.		Wages for labor.
				Quantity (cubic feet).	Value.	
1902	169	369	107		$195,992	$55,618
1903	210	312	138		196,535	79,945
1904	176	231			253,524	53,674
1905	273	462½	130		316,476	88,865
1906	332	550	108	2,534,290,000	533,446	64,968
1907	582	810	191	4,155,900,000	746,499	110,832
1908	656	850	152	4,483,000,000	988,616	106,786
1909	744	987	171	5,388,000,000	1,188,179	103,672

In 1908 there were 281 producing gas wells in the Welland field, 252 in the Haldimand field, and 35 in the Essex-Kent field.

Alberta.—Little information has been obtained regarding the production of gas in the Province of Alberta since 1905, when gas valued at $33,000 was produced from wells at Medicine Hat, but it has now been proved that the existence of natural gas in commercial quantities is not confined to the city of Medicine Hat and its immediate vicinity. The Canadian Pacific Railway, during the last few years, has been doing a great deal of drilling in search for oil and gas at various points in central Alberta, and has struck large flows of gas at Dunmore Junction, 4 miles east of Medicine Hat; at Suffield, about 26 miles northwest of that city; and at Bow Island, about 40 miles southwest of the same point, at which last-named place a well with an estimated capacity of 4,000,000 cubic feet of gas daily was struck at a depth of 1,900 feet.

At the close of 1908 there were 12 producing gas wells in this field.

NEW BRUNSWICK.

The most important development in 1909 in the oil, shale, and gas fields of New Brunswick was the drilling of two gas wells by the Maritime Oil Fields (Limited), of Mr. J. C. A. Henderson's office, London, and successors to the New Brunswick Petroleum Company, which, still further back, was known as the Brunswick Petroleum Company. The discoveries have been made in Albert County, some 12 miles down the Petitcodiac River from Moncton. They have proved a natural gas and oil producing property of some 10,000 square miles.

The Maritime Company erected the first rig in April, 1909, and commenced drilling No. 1 well near Leger's Corner, about 3 miles from Moncton, going to a depth of 1,300 feet without much result. The second rig was erected 12 miles east of Moncton and 3 miles from Memramcook, at which there were some indications of gas at 2,300 feet. No. 3 was located 4 miles north of Hillsborough in Albert County, at 1,700 feet. This proved to be a small producer of oil, together with about 300,000 cubic feet of gas, every twenty-four hours. This was the first important discovery of gas. No. 4 well was located in the Dover district, and at 1,700 feet there was a slight showing of oil and gas. The gas from No. 3 was used to give power for No. 5. No. 5 proved a valuable gas well, producing, according to measurements, over 1,000,000 cubic feet of gas in each twenty-four hours. Each well in drilling consumed about 120,000 cubic feet of gas daily, but only took a small part of the production of No. 5. No. 6 well, 700 feet north of No. 5, was drilled to 1,300 feet, when it was deemed advisable to suspend operations owing to the approach of winter. No. 7 rig, 1,050 feet west of No. 3, was completed, and it was intended to start drilling in 1910, as well as at No. 8, about 700 feet north of No. 7, where a rig was being erected.

The sands on the Albert County side are said to be heavier and less disturbed from a geological standpoint than those in Westmorland, and the field there is to that extent the more promising. The oil and gas are from what is known as the Devonian sands, very similar to those of the Bradford fields in Pennsylvania. The gas is free from sulphur and practically dry, being free from water or gasoline.

TRINIDAD.

A large supply of natural gas is going to waste on the island of Trinidad. This gas piped to Port of Spain would be a great source of revenue. The city, at present poorly lighted in spots by electricity, could be well illuminated at a very small cost. The gas is under high pressure. The discharge from the No. 8 well at Guayaguayan was at the rate of about 1,000,000 feet per day. Every well drilled on the island so far has produced large quantities of gas in addition to the oil.

UNITED KINGDOM.

Recently there has been considerable effort to develop natural gas at Heathfield, Sussex County, England, where natural gas has been used locally for several years. During the year 1909 the amount of natural gas obtained at Heathfield was 236,800 cubic feet, of which 81,850 cubic feet were used for lighting the railway station at Heathfield, and the remaining 154,950 cubic feet were supplied to the East Sussex Gas and Water Company.

The annual report of the British home office gives the statistics of the production and value of natural gas in the United Kingdom [a] for the years 1902 to 1909, as follows:

Production and value of natural gas at Heathfield, England, 1902–1909.

Year.	Quantity.	Value.
	Cubic feet.	
1902	150,000	$146
1903	972,460	944
1904	774,800	754
1905	(b)	(b)
1906	(b)	(b)
1907	(b)	(b)
1908	(b)	(b)
1909	236,800	(c)

a Heathfield in Sussex County.

b None reported. The railway station at Heathfield, however, is lighted with it, but the quantity is not ascertained.

c Not stated.

ITALY.

The Rivista Minerario gives the production and value of natural gas in Italy from 1903 to 1909, as follows:

Production and value of natural gas in Italy, 1903–1909.

Year.	Quantity (cubic meters).	Value.
1903	2,255,596	$15,024
1904	2,551,396	16,715
1905	3,092,000	19,310
1906	5,723,469	32,394
1907	5,710,000	32,279
1908	6,737,500	33,809
1909	8,268,000	42,287

HUNGARY.

Gas has been noted for years in southeastern Hungary, where it can be seen escaping from salt marshes. In 1908 drilling operations for salt in Transylvania, about 30 miles from the city of Kolozsveir, developed considerable gas, and by the advice of the director of the geological survey of Hungary this gas was systematically exploited by the Hungarian Government under the minister of finance. At 500 feet a very large volume of gas was developed, and at 700 feet an even larger amount. The well shows a capacity of 25,000,000 cubic feet per day. The gas occurs in sand layers in a well-developed system of anticlines, and has a good cover of close-grained clays and marls. By the advice of the director of the geological survey, the minister of finance sent a commission to the United States during 1910 for the study of the utilization of natural gas in this country, preparatory to developing industries in Hungary based on this fuel.

RUSSIA.

Although natural gas was first noted in Russia its use has been practically neglected up to the present time. Within the last few years the decline in the production of oil has necessitated many economies in its production, and among these has been the utilization of the natural gas issuing from the oil wells, particularly for pumping the oil. The utilization has been somewhat difficult on account of the large size of many of the wells and the difficulty of inclosing and piping the natural gas where the oil is obtained by the primitive bailing process. The gas is now used to a considerable extent under steam boilers in running the bailers and ordinary oil pumps, and the use of the gas for internal combustion in gas engines has been proposed. The proposition has received little favorable attention, however, both because of the lack of care with which the gas engines would probably be handled in Russia and on account of the rapid cutting of piston valves from the characteristic sand storms in the region. With additional attention to the occurrence of natural gas it is not surprising that much larger quantities should be found. This has been particularly the case in Surakhany.

Utilization of natural gas has been adopted in the Grosny oil field, where four companies are burning it under boilers for the production of steam for oil pumps. Analyses indicate a lower percentage of methane (54.80 per cent) than in Pennsylvania gas, and a larger proportion of nitrogen and oxygen. It is believed, however, that this is largely due to a mixture of air.

The equivalent of gas reckoned in gallons of oil produced on the Surakhany gas field in 1909 was 22,548,969 gallons, to which must be added 1,312,619 gallons of white oil and 7,509,455 gallons of dark crude oil. Activity in this field is increasing and there are now 11 wells producing gas, 3 wells producing white oil, 3 wells producing dark crude oil, 26 wells being drilled, and 10 wells being deepened and repaired. Since the beginning of 1910 a large spouter of light crude oil has been struck, which is still producing.

INDIA.

Consul-General William H. Michael, of Calcutta, writes that 20 miles from Chittagong natural gas issues from a crevice in the ground in considerable quantity. It has been burning so long that the oldest inhabitant can give no idea of when or how it was set on fire. The general belief among the natives is that the gas has been on fire for centuries. At any rate, the gas flow has been burning as far back as any records have been kept by white people. It is now suggested—and some steps have been taken to carry out the suggestion—that the fire be extinguished and the gas be brought under control and piped down to Chittagong for light and fuel and power. The citizens of Chittagong have concluded that it would be cheaper to utilize the gas than to introduce electricity.

PETROLEUM.

By David T. Day.

INTRODUCTION.

In 1907 the oil product of the United States, which had been increasing rapidly in previous years, made a phenomenal gain—over 30 per cent—and reached the great total of 166,095,335 barrels. This gain was due to the sudden development of the Illinois field and to great increases in the fields farther west in Oklahoma and California. In 1908 and 1909 this production was sustained and has even increased, though by no great percentage. In 1908 the quantity produced rose to 178,527,355 barrels, and in 1909 also, the record showed a slight gain—182,134,274 barrels; but there was a decline in value from $129,079,184 in 1908 to $128,248,783 in 1909. The average price per barrel was $0.723 in 1908 and $0.704 in 1909. This is consistent with the increase in stocks during the year. Only three States contributed greatly to the increase in quantity produced. California took first place by gaining 21.35 per cent, Oklahoma increased 4.5 per cent, and West Virginia 12.83 per cent. Utah and Wyoming produced only 22,137 barrels, but this was a gain of 24.55 per cent over their combined output in 1908. In all other States decreases were noted, the greatest decline, 47.15 per cent, being in Louisiana.

California commanded the attention and interest of oil producers during 1909, and this interest increased with the prospect of a total so great in 1910 as to more than offset the declines expected in the other oil fields.

These features are shown in detail in the tables which follow.

COOPERATIVE WORK WITH THE BUREAU OF THE CENSUS.

The present report is based as heretofore on the returns from pipe lines, railroads, and from producers whose output was not already included in those returns. This statistical method has been supplemented for the last three years by direct returns resulting from a canvass of all producing companies in the United States. This canvass involves great labor and expense, but the producers are coming to share the belief that the method adopted will greatly increase statistical accuracy, as it has increased the accuracy of the statistics of coal production obtained directly from the producers instead of from transportation companies, as was originally the custom.

The returns from petroleum producers for the year 1909 have been collected in cooperation with the Bureau of the Census. All the oil companies also have cooperated most satisfactorily in this work.

ACKNOWLEDGMENTS.

In preparing this report much valuable information has been obtained from the Oil Investors' Journal, now the Oil and Gas Journal, of St. Louis; the Oil, Paint, and Drug Reporter; the Oil City Derrick; the Petroleum Gazette; the California Derrick; the Petroleum Review, of London; and the Moniteur du Pétrol Roumain. The various pipe-line companies of the United States have given untiring aid. Many items have also been obtained in cooperation with Mr. F. W. De Wolf, acting director of the Illinois Geological Survey, and with Messrs. Ralph Arnold, M. J. Munn, A. C. Veatch, C. W. Washburne, Carl D. Smith, E. G. Woodruff, and C. H. Wegemann, of the United States Geological Survey. Credit should be given the Oil City Derrick for well-record tables for Pennsylvania and New York, Ohio, Indiana, West Virginia, Illinois, Kentucky, Kansas, and Oklahoma; and to the Oil Investors' Journal for well-record tables for Texas and Louisiana.

PRODUCTION.

The statement of production by States is given in the following table:

Total quantity and value of petroleum produced in the United States and the average price per barrel in 1908 and 1909, by States.

State.	1908. Quantity.	1908. Value.	1908. Average price per barrel.	1909. Quantity.	1909. Value.	1909. Average price per barrel.
	Barrels.			*Barrels.*		
California	44,854,737	$23,433,502	$0.523	54,433,010	$30,675,267	$0.564
Colorado	379,653	346,403	.913	310,771	317,712	1.022
Illinois	33,686,238	22,649,561	.672	30,898,339	19,788,864	.640
Indiana	3,283,629	3,203,883	.976	2,296,086	1,997,610	.870
Kansas	1,801,781	746,695	.414	1,263,764	491,633	.389
Kentucky	727,767	706,811	.971	639,016	518,299	.811
Louisiana	5,788,874	3,503,419	.605	3,059,531	2,022,449	.661
Michigan, Missouri	15,246	22,345	1.466	5,750	7,830	1.362
New York	1,160,128	2,071,533	1.786	1,134,897	1,878,217	1.655
Ohio	10,858,797	14,178,502	1.306	10,632,793	13,225,377	1.244
Oklahoma	45,798,765	17,694,843	.386	47,859,218	17,428,990	.364
Pennsylvania	9,424,325	16,881,194	1.791	9,299,403	15,424,554	1.659
Texas	11,206,464	6,700,708	.598	9,534,467	6,793,050	.712
Utah, Wyoming	17,775	27,920	1.570	22,137	36,648	1.655
West Virginia	9,523,176	16,911,865	1.776	10,745,092	17,642,283	1.642
Total	178,527,355	129,079,184	.723	182,134,274	128,248,783	.704

The increase or decrease in production by States, as well as the percentage of increase or decrease in 1909 compared with 1908, are shown in the following table. The striking features of production were the increase in both quantity and percentage in California and the sharp declines in both in Illinois, Indiana, Kansas, and Louisiana:

Total production of petroleum and percentage of increase or decrease, by States, in 1909, as compared with 1908, in barrels.

State.	Production.		Increase.	Decrease.	Per cent.	
	1908.	1909.			Increase.	Decrease.
California	44,854,737	54,433,010	9,578,273	....	21.35	....
Colorado	379,653	310,771	....	68,882	....	18.14
Illinois	33,686,238	30,898,339	....	2,787,899	....	8.28
Indiana	3,283,629	2,296,086	....	987,543	....	30.07
Kansas	1,801,781	1,263,764	....	538,017	....	29.86
Kentucky	727,767	639,016	....	88,751	....	12.20
Louisiana	5,788,874	3,059,531	....	2,729,343	....	47.15
Michigan Missouri	15,246	5,750	....	9,496	....	62.28
New York	1,160,128	1,134,897	....	25,231	....	2.17
Ohio	10,858,797	10,632,793	....	226,004	....	2.08
Oklahoma	45,798,765	47,859,218	2,060,453	....	4.50	....
Pennsylvania	9,424,325	9,299,403	....	124,922	....	1.33
Texas	11,206,464	9,534,467	....	1,671,997	....	14.92
Utah Wyoming	17,775	22,137	4,362	....	24.55	....
West Virginia	9,523,176	10,745,092	1,221,916	....	12.83	....
Total	178,527,355	182,134,274	3,606,919	....	2.02	....

RANK OF PRODUCING STATES.

QUANTITY.

California, as was expected, took first place in petroleum production, changing places with Oklahoma. California's product was about 6,500,000 barrels more than any other State has ever produced in a year. Should California show a further proportionate increase in 1910, the total would be more than double the highest yield of Pennsylvania.

West Virginia's increase brought that State from sixth to fourth on the list, exchanging places with Texas. All the other States retained their rank of the year 1908.

Rank of petroleum-producing States, with quantity and percentage produced by each, in 1908 and 1909, in barrels.

1908.				1909.			
State.	Rank.	Quantity.	Per cent.	State.	Rank.	Quantity.	Per cent.
Oklahoma	1	45,798,765	25.65	California	1	54,433,010	29.89
California	2	44,854,737	25.13	Oklahoma	2	47,859,218	26.28
Illinois	3	33,686,238	18.87	Illinois	3	30,898,339	16.96
Texas	4	11,206,464	6.28	West Virginia	4	10,745,092	5.90
Ohio	5	10,858,797	6.08	Ohio	5	10,632,793	5.84
West Virginia	6	9,523,176	5.33	Texas	6	9,534,467	5.23
Pennsylvania	7	9,424,325	5.28	Pennsylvania	7	9,299,403	5.11
Louisiana	8	5,788,874	3.24	Louisiana	8	3,059,531	1.68
Indiana	9	3,283,629	1.84	Indiana	9	2,296,086	1.26
Kansas	10	1,801,781	1.01	Kansas	10	1,263,764	.69
New York	11	1,160,128	.65	New York	11	1,134,897	.62
Kentucky	12	727,767	.41	Kentucky	12	639,016	.35
Colorado	13	379,653	.21	Colorado	13	310,771	.17
Wyoming, Utah	14	17,775	.01	Wyoming, Michigan, Missouri, Utah	14	27,887	.02
Missouri, Michigan	15	15,246	.01				
Total	......	178,527,355	100.00	Total	......	182,134,274	100.00

VALUE.

California was first in value as well as in quantity of petroleum produced, and, as forecasted in the report for 1908, a higher price increased the value by a percentage greater than the percentage of increase in quantity. The total value increased nearly 31 per cent.

The other changes in relative values were of no importance, though it is interesting to notice that West Virginia, with so much smaller a product, exceeded Oklahoma in total value.

Rank of petroleum-producing States, with value of production and percentage of each, in 1908 and 1909.

1908.				1909.			
State.	Rank.	Value.	Per cent.	State.	Rank.	Value.	Per cent.
California	1	$23,433,502	18.15	California	1	$30,675,267	23.92
Illinois	2	22,649,561	17.55	Illinois	2	19,788,864	15.43
Oklahoma	3	17,694,843	13.71	West Virginia	3	17,642,283	13.76
West Virginia	4	16,911,865	13.10	Oklahoma	4	17,428,990	13.59
Pennsylvania	5	16,881,194	13.08	Pennsylvania	5	15,424,554	12.03
Ohio	6	14,178,502	10.98	Ohio	6	13,225,377	10.31
Texas	7	6,700,708	5.20	Texas	7	6,793,050	5.30
Louisiana	8	3,503,419	2.71	Louisiana	8	2,022,449	1.58
Indiana	9	3,203,883	2.48	Indiana	9	1,997,610	1.56
New York	10	2,071,533	1.60	New York	10	1,878,217	1.46
Kansas	11	746,695	.58	Kentucky	11	518,299	.40
Kentucky	12	706,811	.55	Kansas	12	491,633	.38
Colorado	13	346,403	.27	Colorado	13	317,712	.25
Missouri, Utah, Wyoming, Michigan	14	50,265	.04	Wyoming, Missouri, Michigan, Utah	14	44,478	.03+
Total	......	129,079,184	100.00	Total	......	128,248,783	100.00

PRODUCTION OF PETROLEUM IN THE UNITED STATES FROM 1859 TO 1909, INCLUSIVE.

In the following table will be found a statement of the production of petroleum from each producing State of the United States from the year 1859 to and including the production of the year 1909:

Production of petroleum in the United States, 1859–1909, by years and by States, in barrels of 42 gallons.

Year.	Pennsylvania and New York.	Ohio.	West Virginia.	California.	Kentucky and Tennessee.	Colorado.	Indiana.	Illinois.
1859	2,000							
1860	500,000							
1861	2,113,609							
1862	3,056,690							
1863	2,611,309							
1864	2,116,109							
1865	2,497,700							
1866	3,597,700							
1867	3,347,300							
1868	3,646,117							
1869	4,215,000							
1870	5,260,745							
1871	5,205,234							
1872	6,293,194							
1873	9,893,786							
1874	10,926,945							
1875	8,787,514							
1876	8,968,906	31,763	120,000	12,000				
1877	13,135,475	29,888	172,000	13,000				
1878	15,163,462	38,179	180,000	15,227				
1879	19,685,176	29,112	180,000	19,858				
1880	26,027,631	38,940	179,000	40,552				
1881	27,376,509	33,867	151,000	99,862				
1882	30,053,500	39,761	128,000	128,636				
1883	23,128,389	47,632	126,000	142,857	4,755			
1884	23,772,209	90,081	90,000	262,000	4,148			
1885	20,776,041	661,580	91,000	325,000	5,164			
1886	25,798,000	1,782,970	102,000	377,145	4,726			
1887	22,356,193	5,022,632	145,000	678,572	4,791	76,295		
1888	16,488,668	10,010,868	119,448	690,333	5,096	297,612		
1889	21,487,435	12,471,466	544,113	303,220	5,400	316,476	33,375	1,460
1890	28,458,208	16,124,656	492,578	307,360	6,000	368,842	63,496	900
1891	33,009,236	17,740,301	2,406,218	323,600	9,000	665,482	136,634	675
1892	28,422,377	16,362,921	3,810,086	385,049	6,500	824,000	698,068	521
1893	20,314,513	16,249,769	8,445,412	470,179	3,000	594,390	2,335,293	400
1894	19,019,990	16,792,154	8,577,624	705,969	1,500	515,746	3,688,666	300
1895	19,144,390	19,545,233	8,120,125	1,208,482	1,500	438,232	4,386,132	200
1896	20,584,421	23,941,169	10,019,770	1,252,777	1,680	361,450	4,680,732	250
1897	19,262,066	21,560,515	13,090,045	1,903,411	322	384,934	4,122,356	500
1898	15,948,464	18,738,708	13,615,101	2,257,207	5,568	444,383	3,730,907	360
1899	14,374,512	21,142,108	13,910,630	2,642,095	18,280	390,278	3,848,182	360
1900	14,559,127	22,362,730	16,195,675	4,324,484	62,259	317,385	4,874,392	200
1901	13,831,996	21,648,083	14,177,126	8,786,330	137,259	460,520	5,757,086	250
1902	13,183,610	21,014,231	13,513,345	13,984,268	185,331	396,901	7,480,896	200
1903	12,518,134	20,480,286	12,899,395	24,382,472	554,286	483,925	9,186,411	
1904	12,239,026	18,876,631	12,644,686	29,649,434	998,284	501,763	11,339,124	
1905	11,554,777	16,346,660	11,578,110	33,427,473	1,217,337	376,238	10,964,247	181,084
1906	11,500,410	14,787,763	10,120,935	33,098,598	1,213,548	327,582	7,673,477	4,397,050
1907	11,211,606	12,207,448	9,095,296	39,748,375	820,844	331,851	5,128,037	24,281,973
1908	10,584,453	10,858,797	9,523,176	44,854,737	[a] 727,767	379,653	3,283,629	33,686,238
1909	10,434,300	10,632,793	10,745,092	54,433,010	[a] 639,016	310,771	2,296,086	30,898,339
Total	708,444,162	387,741,695	205,307,986	301,253,572	6,643,361	9,564,709	95,707,226	93,451,260

[a] No production in Tennessee recorded.

Production of petroleum in the United States, 1859–1909, by years and by States, in barrels of 42 gallons—Continued.

Year.	Kansas.	Texas.	Missouri.	Oklahoma.	Wyoming.	Louisiana.	United States.	Total value.
1859	....	....	....	....	....	....	2,000	$32,000
1860	....	....	....	....	....	....	500,000	4,800,000
1861	....	....	....	....	....	....	2,113,609	1,035,668
1862	....	....	....	....	....	....	3,056,690	3,209,525
1863	....	....	....	....	....	....	2,611,309	8,225,663
1864	....	....	....	....	....	....	2,116,109	20,896,576
1865	....	....	....	....	....	....	2,497,700	16,459,853
1866	....	....	....	....	....	....	3,597,700	13,455,398
1867	....	....	....	....	....	....	3,347,300	8,066,993
1868	....	....	....	....	....	....	3,646,117	13,217,174
1869	....	....	....	....	....	....	4,215,000	23,730,450
1870	....	....	....	....	....	....	5,260,745	20,503,754
1871	....	....	....	....	....	....	5,205,234	22,591,180
1872	....	....	....	....	....	....	6,293,194	21,440,503
1873	....	....	....	....	....	....	9,893,786	18,100,464
1874	....	....	....	....	....	....	10,926,945	12,647,527
1875	....	....	....	....	....	....	8,787,514	7,368,133
1876	....	....	....	....	....	....	9,132,669	22,982,822
1877	....	....	....	....	....	....	13,350,363	31,788,566
1878	....	....	....	....	....	....	15,396,868	18,044,520
1879	....	....	....	....	....	....	19,914,146	17,210,708
1880	....	....	....	....	....	....	26,286,123	24,600,638
1881	....	....	....	....	....	....	27,661,238	23,512,051
1882	....	....	....	....	....	....	30,349,897	23,631,165
1883	....	....	....	....	....	....	23,449,633	25,740,252
1884	....	....	....	....	....	....	24,218,438	20,476,924
1885	....	....	....	....	....	....	21,858,785	19,193,694
1886	....	....	....	....	....	....	28,064,841	20,028,457
1887	....	....	....	....	....	....	28,283,483	18,856,606
1888	....	....	....	....	....	....	27,612,025	17,950,353
1889	500	48	20	....	....	....	35,163,513	26,963,340
1890	1,200	54	278	....	....	....	45,823,572	35,365,105
1891	1,400	54	25	30	....	....	54,292,655	30,526,553
1892	5,000	45	10	80	....	....	50,514,657	25,906,463
1893	18,000	50	50	10	....	....	48,431,066	28,932,326
1894	40,000	60	8	130	2,369	....	49,344,516	35,522,095
1895	44,430	50	10	37	3,455	....	52,892,276	57,691,279
1896	113,571	1,450	43	170	2,878	....	60,960,361	58,518,709
1897	81,098	65,975	19	625	3,650	....	60,475,516	40,929,611
1898	71,980	546,070	10	....	5,475	....	55,364,233	44,193,359
1899	69,700	669,013	132	....	5,560	....	57,070,850	64,603,904
1900	74,714	836,039	[a] 1,602	6,472	5,450	....	63,620,529	75,752,691
1901	179,151	4,393,658	[b] 2,335	10,000	5,400	....	69,389,194	66,417,335
1902	331,749	18,083,658	[a] 757	37,100	6,253	548,617	88,766,916	71,178,910
1903	932,214	17,955,572	[a] 3,000	138,911	8,960	917,771	100,461,337	94,694,050
1904	4,250,779	22,241,413	[a] 2,572	1,366,748	11,542	2,958,958	117,080,960	101,175,455
1905	[c] 12,013,495	28,136,189	[a] 3,100	(d)	8,454	8,910,416	134,717,580	84,157,399
1906	[c] 21,718,648	12,567,897	[a] 3,500	(d)	[e] 7,000	9,077,528	126,493,936	92,444,735
1907	2,409,521	12,322,696	[a] 4,000	43,524,128	[f] 9,339	5,000,221	166,095,335	120,106,749
1908	1,801,781	11,206,464	[a] 15,246	45,798,765	[f] 17,775	5,788,874	178,527,355	129,079,184
1909	1,263,764	9,534,467	[a] 5,750	47,859,218	[f] 22,137	3,059,531	182,134,274	128,248,783
Total	45,422,695	138,560,922	42,467	138,742,424	125,697	36,261,916	2,167,270,092	1,912,205,652

[a] Includes the production of Michigan.
[b] Includes production of Michigan and small production in Oklahoma.
[c] Includes production of Oklahoma.
[d] Included with Kansas.
[e] Estimated.
[f] Includes the production of Utah.

CONSUMPTION OF FUEL OIL.

RAILROADS.

UNITED STATES.

It will be seen from the following table that the use of fuel oil by the railroads of the United States is on the increase, the consumption in 1909 amounting to 19,939,394 barrels, an increase of 3,050,324 barrels, or 18.6 per cent, as compared with 16,889,070 barrels in 1908; it was 18,855,691 barrels in 1907. The mileage made per barrel of oil consumed in 1909 was 3.66 miles, as compared with 3.81 miles in 1908 and with 3.93 miles in 1907. Most of the oil consumed on the railroads is crude oil, but a considerable quantity of residuum also is used, this being the product left after the lighter oils have been extracted by refining.

The following are the names of the railroad companies which used fuel oil on their lines in 1909: The Sunset Lines of California, Texas, and Louisiana (embracing the Southern Pacific Co. (Pacific System), the Oregon Railroad & Navigation Co., the Oregon Short Line Railroad, the Galveston, Harrisburg & San Antonio Railway Co., the Texas & New Orleans Railroad Co., the Houston & Texas Central Railroad Co., the Houston East & West Texas Railway, the Houston & Shreveport Railroad, and the Louisiana Western Railroad); the Frisco Lines (including the St. Louis & San Francisco Railroad Co. in Missouri, Kansas, Texas, and Oklahoma, and the Chicago, Rock Island & Pacific Railway, in Kansas and Oklahoma); the Atchison, Topeka & Santa Fe Railway Co.; the Kansas City Southern Railway, in Texas and Louisiana; the International & Great Northern Railroad Co., in Texas; the San Pedro, Los Angeles & Salt Lake Railroad; the St. Louis, Brownsville & Mexico Railway, in Texas; the Trinity & Brazos Valley Railway Co., in Texas; the Galveston, Houston & Henderson Railroad, in Texas; the San Antonio & Aransas Pass Railway Co., in Texas; the Texas & Pacific Railway Co., in Texas; and the Chicago & North Western Railway Co., in Wyoming.

Very considerable development in the size of oil-burning locomotives has been attempted. An oil-burning locomotive weighing 300 tons has been built for the Southern Pacific Co. for hauling freight over the Sierras between Sacramento and Reno, Nev. The necessity for oil burners in such monster constructions is evident, since the stoking requirements with coal exceed the powers of any fireman.

Consumption of fuel oil by the railroads of the United States, 1906–1909.

Year.	Length of line operated by the use of fuel oil.[a]	Quantity of fuel oil consumed by railroads.	Total mileage made by oil-burning engines.	Average number of miles per barrel of oil consumed.
	Miles.	*Barrels.*	*Miles.*	*Miles.*
1906		15,577,677		
1907	13,573	[b] 18,855,002	74,079,726	3.93
1908	15,474	[c] 16,889,070	64,279,509	3.81
1909	17,676	[d] 19,939,394	72,918,118	3.66

[a] Some of these lines also used coal.
[b] Includes 5,199 barrels used for shop purposes.
[c] Includes 18,188 barrels used for shop purposes.
[d] Includes 34,059 barrels used for firing engines and for shop boilers.

FOREIGN COUNTRIES.

Mexico.—The eventual use of liquid fuel exclusively in Mexico waits only on the production of a sufficient supply, for which recent developments make the outlook hopeful.

Panama.—At the beginning of 1909 practically all of the stationary boilers in the Isthmian Canal Commission's work were heated by fuel oil. The monthly consumption of fuel oil has reached 25,000 barrels, with an actual saving of at least 65 per cent in cost by the substitution of oil for coal. It is estimated that a barrel of oil will generate as much steam as a quarter of a ton of coal.

Roumania.—In 1888 liquid fuel played only an insignificant rôle in the Roumanian railway system, only 5 locomotives being thus heated; in 1909 there were 549 such locomotives burning 179,966 tons of liquid fuel a year; and 80 more locomotives are to be added to the oil-burning list in 1910. Only 99 locomotives in all now burn coal or wood.

Austria.—On account of the increase in the production of petroleum in Galicia, the Austrian state railways used liquid fuel on 773 locomotives in 1909, and there is prospect of introducing the same improvement on all the mountain railways.

Russia.—A commission is studying methods of extending the use of fuel oil on Russian state railways; the government receives the oil as royalty from producers on government lands. Mr. E. de Hautpick has shown[a] that about 6,000,000 tons of fuel oil are annually consumed in Russia. Of this, 3,000,000 tons are used on railways and over 1,500,000 tons on steamers on the Volga and tributary rivers and on the Caspian Sea. Factories and agriculture consume the remainder. Moscow's factories alone consume about 500,000 tons. Although the Donetz coal basin lies much nearer the Moscow district, still oil produced three times as far away has the advantage, because under the conditions of burning which prevail 1 ton of oil is claimed to do the work of 2 tons of coal.

Italy.—The Modena Railway in Italy has seen the necessity for introducing liquid fuel wherever steep inclines and numerous tunnels have to be dealt with.

USE OF FUEL OIL IN THE UNITED STATES NAVY.

The introduction of fuel oil into the United States Navy has been quite rapid and with fully as good results as were anticipated.

During 1909 and 1910 two battleships, the *North Dakota* and the *Delaware*, were equipped with auxiliary oil-burning plants. In spite of a regrettable fatal accident in the fire room of the *North Dakota*, by which two lives were lost from ignition of the oil, the tests have been so satisfactory that the battleships *Florida*, *Utah*, *Wyoming*, and *Arkansas*, which are now building, will each carry 400 tons of fuel oil to be burned as auxiliary to coal; and the destroyers *Paulding*, *Drayton*, *Roe*, *Terry*, *Perkins*, *Sterett*, *McCall*, *Burrows*, *Warrington*, *Mayrant*, *Monaghan*, *Trippe*, *Walke*, *Ammen*, and *Patterson* will each carry over 200 tons of fuel oil and will burn oil exclusively.

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[a] Mining Journal, London, July 9, 1910.

In England, Germany, France, Austria, Italy, and Russia, similar experiments are being made.

OIL FIELDS OF THE UNITED STATES.

A general description of the oil fields of the United States was published in Mineral Resources for the years 1907 and 1908, to which the reader is referred.

SURVEY PUBLICATIONS, 1901-1910, ON THE OIL FIELDS OF THE UNITED STATES.

As the result of the field work of 1909 and of earlier investigations the following publications have been made by the United States Geological Survey:

PROFESSIONAL PAPERS.

56. Geography and geology of a portion of southwestern Wyoming, with special reference to coal and oil, by A. C. Veatch. 1907. 178 pp., 26 pls.
65. Geology and underground waters of the northern Black Hills region, by N. H. Darton. 1909. 106 pp., 24 pls.

BULLETINS.

[a]184. Oil and gas fields of the western interior and northern Texas coal measures and of the Upper Cretaceous and Tertiary of the western Gulf coast, by George I. Adams. 1901. 64 pp., 10 pls. 30c.

198. The Berea grit oil sand in the Cadiz quadrangle, Ohio, by W. T. Griswold. 1902. 43 pp., 1 pl.

[a]212. Oil fields of the Texas-Louisiana Gulf coastal plain, by C. W. Hayes and William Kennedy. 1903. 174 pp., 11 pls. 20c.

[a]213. Contributions to economic geology. 1902; S. F. Emmons and C. W. Hayes, geologists in charge. 1903. 449 pp. 25c.

    The petroleum fields of California, by George H. Eldridge, p. 306.
    The Boulder, Colo., oil field, by N. M. Fenneman, p. 322.
    Asphalt, oil, and gas in southwestern Indiana, by Myron L. Fuller, p. 333.
    Structural work during 1901 and 1902 in the eastern oil fields, by W. T. Griswold, p. 336.
    Oil fields of the Texas-Louisiana Gulf coastal plain, by C. W. Hayes, p. 345.

[a]225. Contributions to economic geology, 1903; S. F. Emmons and C. W. Hayes, geologists in charge. 1904. 527 pp., 1 pl. 35c.

    Petroleum fields of Alaska and the Bering River coal field, by G. C. Martin, p. 365.
    Structure of the Boulder oil field, Colorado, with records for the year 1903, by N. M. Fenneman, p. 383.
    The Hyner gas pool, Pennsylvania, by M. L. Fuller, p. 392.
    Oil and gas fields of eastern Greene County, Pa., by Ralph W. Stone, p. 396.

[a]238. Economic geology of the Iola quadrangle, Kansas, by G. I. Adams, Erasmus Haworth, and W. R. Crane. 1904. 83 pp., 11 pls. 25c.

250. The petroleum fields of the Pacific coast of Alaska, with an account of the Bering River coal deposits, by G. C. Martin. 1905. 64 pp., 7 pls.

256. Mineral resources of the Elders Ridge quadrangle, Pennsylvania, by R. W. Stone. 1905. 86 pp., 12 pls.

259. Report on progress of investigations of mineral resources of Alaska in 1904, by A. H. Brooks and others. 1905. 196 pp., 3 pls. 15c.

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[a] This mark indicates that the Geological Survey's stock of the paper is exhausted. Many of the papers marked in this way may, however, be purchased from the Superintendent of Documents, Washington, D. C., at the prices indicated.

[a]260. Contributions to economic geology, 1904; by S. F. Emmons and C. W. Hayes, geologists in charge. 1905. 620 pp., 4 pls. 40c.
The Florence, Colo., oil field, by N. M. Fenneman, p. 436.
Notes on the geology of the Muscogee oil field, Oklahoma, by J. A. Taff and M. K. Shaler, p. 441.
Oil and gas in the Independence quadrangle, Kansas, by F. C. Schrader and Erasmus Haworth, p. 446.
Oil fields of the Texas-Louisiana Gulf coast, by N. M. Fenneman, p. 459.
Oil and asphalt prospects in Salt Lake Basin, Utah, by J. M. Boutwell, p. 468.

264. Record of deep-well drilling for 1904, by M. L. Fuller, E. F. Lines, and A. C. Veatch. 1905. 106 pp.

265. Geology of the Boulder district, Colorado, by N. M. Fenneman. 1905. 101 pp., 5 pls.

279. Economic geology of the Kittanning and Rural Valley quadrangles, Pennsylvania, by Charles Butts. 1906. 198 pp., 11 pls.

282. Oil fields of the Texas-Louisiana Gulf Coastal Plain, by N. M. Fenneman. 1906. 146 pp., 11 pls.

[a]285. Contributions to economic geology, 1905; S. F. Emmons and E. C. Eckel, geologists in charge. 1906. 506 pp., 13 pls. 60c.
The Salt Lake oil field near Los Angeles, Cal., by Ralph Arnold, p. 357.
The Nineveh and Gordon oil sands in western Greene County, Pa., by F. G. Clapp, p. 362.

286. Economic geology of the Beaver quadrangle, Pennsylvania, by L. H. Woolsey. 1906. 132 pp., 8 pls.

296. Economic geology of the Independence quadrangle, Kansas, by F. C. Schrader and Erasmus Haworth. 1906. 74 pp., 6 pls.

298. Record of deep-well drilling for 1905, by Myron L. Fuller and Samuel Sanford. 1906. 299 pp. 25c.

300. Economic geology of the Amity quadrangle in eastern Washington County, Pa., by F. G. Clapp. 1907. 145 pp., 8 pls.

304. Oil and gas fields of Greene County, Pa., by R. W. Stone and F. G. Clapp. 1907. 110 pp., 3 pls.

309. The Santa Clara Valley, Puente Hills, and Los Angeles oil districts, southern California, by G. H. Eldridge and Ralph Arnold. 1907. 266 pp., 41 pls. 80c.

314. Report on progress of investigations of mineral resources of Alaska in 1906, by A. H. Brooks and others. 1907. 235 pp., 4 pls. 30c.

317. Preliminary report on the Santa Maria oil district, Santa Barbara County, Cal., by Ralph Arnold and Robert Anderson. 1907. 69 pp., 2 pls. 15c.

318. Geology of oil and gas fields in Steubenville, Burgettstown, and Claysville quadrangles, Ohio, West Virginia, and Pennsylvania, by W. T. Griswold and M. J. Munn. 1907. 196 pp., 13 pls. 75c.

[a]321. Geology and oil resources of the Summerland district, Santa Barbara County, Cal., by Ralph Arnold. 1907. 91 pp., 20 pls. 25c.

[a]322. Geology and oil resources of the Santa Maria oil district, Santa Barbara County, Cal., by Ralph Arnold and Robert Anderson. 1907. 161 pp., 26 pls. 50c.

330. The data of geochemistry, by F. W. Clarke. 1908. 716 pp.

335. Geology and mineral resources of the Controller Bay region, Alaska, by G. C. Martin. 1908. 141 pp., 10 pls.

[a]340. Contributions to economic geology, 1907, Part I: Metals and nonmetals except fuels. 1908. 30c.
Petroleum and natural gas—California: Contra Costa County, Miner ranch field, by Ralph Arnold. Utah: Southern Utah oil field, by G. B. Richardson. Wyoming: Bighorn basin gas fields, by C. W. Washburne; Uinta County, Labarge oil field, by A. R. Schultz, pp. 339–374.

346. Structure of the Berea oil sand in the Flushing quadrangle, Ohio, by W. T. Griswold. 1908. 30 pp., 2 pls.

350. Geology of the Rangely oil district, Colorado, with a section on the water supply, by H. S. Gale. 1908. 60 pp., 4 pls.

357. Preliminary report on the Coalinga oil district in Fresno and Kings Counties, Cal., by Ralph Arnold and Robert Anderson. 1908. 142 pp., 2 pls. 20c.

364. Geology and mineral resources of the Laramie basin, Wyoming, by N. H. Darton and C. E. Siebenthal. 1908. 81 pp., 8 pls.

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[a] This mark indicates that the Geological Survey's stock of the paper is exhausted. Many of the papers marked in this way may, however, be purchased from the Superintendent of Documents, Washington, D. C., at the prices indicated.

365. The fractionation of crude petroleum by capillary diffusion, by J. E. Gilpin and M. P. Cram. 1908. 33 pp.
381. Contributions to economic geology, 1908, Part II: Mineral fuels. M. R. Campbell, geologist in charge. 1910.
    Geology and oil prospects of the Reno region, Nevada, by R. Anderson. Two areas of oil prospecting in Lyon County, western Nevada, by R. Anderson. Analyses of crude petroleum from Oklahoma and Kansas, by D. T. Day. The Madill oil pool, Oklahoma, by J. A. Taff and W. J. Reed. Development in the Boulder and Florence oil fields, Colorado, by C. W. Washburne, pp. 475–544.
394. Papers on the conservation of mineral resources. 1909. 214 pp., 12 pls.
[a] 398. Geology and oil resources of the Coalinga district, California, final report, by Ralph Arnold and Robert Anderson. 85c.
401. Relations between local magnetic disturbances and the genesis of petroleum, by George F. Becker.
406. Preliminary report on the McKittrick-Sunset oil region, Kern and San Luis Obispo Counties, California, by Ralph Arnold and Harry R. Johnson. 225 pp., 5 pls.
415. Coal fields of northwestern Colorado and northeastern Utah, by Hoyt S. Gale. 257 pp., 22 pls.
429. Oil and gas in Louisiana, by G. D. Harris. 1910.
431–A. Advance chapter from "Contributions to economic geology, 1909, Part II: Mineral fuels."
    Petroleum and natural gas by A. G. Leonard, H. E. Gregory, C. W. Washburne, and Robert Anderson.

In preparation.

Reconnaissance report on the geology of the oil and gas fields of the Foxburg quadrangle, Pennsylvania, by M. J. Munn.
Geology of the oil and gas fields of the Carnegie quadrangle, Pennsylvania, by M. J. Munn.
Geology of the Cantua-Panoche oil region, California, by Robert Anderson.
Final report on the McKittrick-Sunset oil region, California, by Robert Anderson.
Geography and geology of part of Uinta County, Wyo., by A. R. Schultz.
Coal and oil of Foxburg quadrangle, Pennsylvania, by E. W. Shaw.
Oil and gas in Pawhuska quadrangle, Oklahoma, by C. D. Smith.
Lander and Salt Creek oil fields, Wyoming, by E. G. Woodruff and C. H. Wegemann.
Diffusion of petroleum through fuller's earth, by J. Elliott Gilpin and O. E. Bransky.

WATER-SUPPLY PAPER.

113. The disposal of strawboard and oil-well wastes, by R. L. Sackett and Isaiah Bowman. 1905. 52 pp., 4 pls.

FOLIOS OF THE GEOLOGIC ATLAS OF THE UNITED STATES CONCERNING PETROLEUM AND NATURAL-GAS FIELDS, 1897–1908.

40. Wartburg, Tenn., by A. Keith. 1897.
53. Standingstone, Tenn., by M. R. Campbell. 1899.
72. Charleston, W. Va., by M. R. Campbell. 1901.
76. Austin, Tex., by R. T. Hill and T. W. Vaughan. 1902.
82. Masontown-Uniontown, Pa., by M. R. Campbell. 1902.
92. Gaines, Pa.-N. Y., by M. L. Fuller and W. C. Alden. 1903.
105. Patoka, Ind.-Ill., by M. L. Fuller and F. G. Clapp. 1904.
107. Newcastle, Wyo.-S. Dak., by N. H. Darton. 1904.
115. Kittanning, Pa., by C. Butts and F. Leverett. 1904.
121. Waynesburg, Pa., by R. W. Stone. 1905.
123. Elders Ridge, Pa., by R. W. Stone. 1905.
125. Rural Valley, Pa., by C. Butts. 1905.
132. Muscogee, Okla., by J. A. Taff. 1906.

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[a] This mark indicates that the Geological Survey's stock of the paper is exhausted. Many of the papers marked in this way may, however, be purchased from the Superintendent of Documents, Washington, D. C., at the prices indicated.

134. Beaver, Pa., by L. H. Woolsey. 1906.
135. Nepesta, Colo., by C. A. Fisher. 1906.
144. Amity, Pa., by F. G. Clapp. 1907.
146. Rogersville, Pa., by F. G. Clapp. 1907.
[a]148. Joplin district, Mo.-Kans., by W. S. T. Smith and C. E. Siebenthal. 1907.
159. Independence, Kans., by F. C. Schrader. 1908.
163. Santa Cruz, Cal., by J. C. Branner, J. F. Newsome, and R. Arnold. 1909.
165. Aberdeen-Redfield, S. Dak., by J. E. Todd.
172. Warren, Pa.-N. Y., by C. Butts.

In preparation.

Sewickley, Pa., by M. J. Munn.

PRODUCTION BY FIELDS.

In the following tables is given the production of petroleum in the United States for the years 1905 to 1909, inclusive, by fields:

Production of petroleum in the United States, 1905–1909, by fields, in barrels.

Field.	1905.	1906.	1907.	1908.	1909.
Appalachian	29,366,960	27,741,472	25,342,137	24,945,517	26,535,844
Lima-Indiana	22,294,171	17,554,661	13,121,094	10,032,305	8,211,443
Illinois	181,084	4,397,050	24,281,973	33,686,238	30,898,339
Mid-Continent	12,535,777	22,838,553	46,846,267	48,323,810	49,804,922
Gulf	36,526,323	20,527,520	16,410,299	16,272,074	11,912,058
California	33,427,473	33,098,598	39,748,375	44,854,737	54,433,010
Other	385,792	336,082	345,190	412,674	338,658
Total	134,717,580	126,493,936	166,095,335	178,527,355	182,134,274

Percentages of total petroleum produced in the several fields, 1905–1909.

Field	1905.	1906.	1907.	1908.	1909.
Appalachian	21.80	21.93	15.26	13.97	14.57
Lima-Indiana	16.55	13.88	7.90	5.62	4.51
Illinois	.14	3.47	14.62	18.87	16.96
Mid-Continent	.30	18.05	28.20	27.07	27.34
Gulf	27.11	16.23	9.88	9.11	6.54
California	24.81	26.17	23.93	25.13	29.89
Other	.29	.27	.21	.23	.19
Total	100.00	100.00	100.00	100.00	100.00

Production of petroleum in the United States in 1908 and 1909, by fields, showing increase or decrease, in barrels.

Field.	Production.		Increase.	Decrease.	Percentage.	
	1908.	1909			Increase.	Decrease.
Appalachian	24,945,517	26,535,844	1,590,327	....	6.38	....
Lima-Indiana	10,032,305	8,211,443	....	1,820,862	....	18.15
Illinois	33,686,238	30,898,339	....	2,787,899	....	8.28
Mid-Continent	48,323,810	49,804,922	1,481,112	....	3.06	....
Gulf	16,272,074	11,912,058	....	4,360,016	....	26.79
California	44,854,737	54,433,010	9,578,273	....	21.35	....
Other	412,674	338,658	....	74,016	....	17.94
Total	178,527,355	182,134,274	3,606,919	....	2.02	....

[a] The price of folio No. 148 is 50 cents. The other folios named are sold at 25 cents each.

Quantity, total value, and price per barrel received at wells for petroleum produced in the United States in 1908 and 1909, by fields, in barrels.

Field.	1908.			1909.		
	Quantity.	Value.	Price per barrel.	Quantity.	Value.	Price per barrel.
Appalachian	24,945,517	$43,888,020	$1.759	26,535,844	$43,237,233	$1.629
Lima-Indiana	10,032,305	10,065,768	1.003	8,211,443	7,449,107	.907
Illinois	33,686,238	22,649,561	.672	30,898,339	19,788,864	.640
Mid-Continent	48,323,810	18,920,610	.392	49,804,922	18,314,355	.368
Gulf	16,272,074	9,725,055	.598	11,912,058	8,421,767	.707
California	44,854,737	23,433,502	.523	54,433,010	30,675,267	.564
Other	412,674	396,668	.961	338,658	362,190	1.069
Total	178,527,355	129,079,184	.723	182,134,274	128,248,783	.704

Deliveries of petroleum in the United States and purposes for which shipped in 1909, by fields, in barrels.

Field.	Total deliveries in 1909.	Delivered for—		
		Refining.	Fuel.	Other purposes.
Appalachian	53,921,153	53,870,530	2,500	[a] 48,123
Lima-Indiana	13,284,766	13,271,779	4,729	[b] 8,258
Illinois	14,703,817	14,585,061	118,686	70
Kansas and Oklahoma	46,190,831	39,243,607	4,683,713	[c] 2,263,511
Louisiana	2,732,308	248,260	2,484,048	....
Texas[d]	10,066,309	4,358,910	5,706,726	673
California	[e] 54,709,087	14,000,000	[e] 37,709,087	[e] 3,000,000
Other	338,917	326,169	10,498	[a] 2,250
Total in 1909	195,947,188	139,904,316	50,719,987	5,322,885
Total in 1908	193,459,209	147,842,110	40,370,261	5,246,838
Total in 1907	172,014,023	136,870,109	32,653,110	2,490,804

[a] Lubricating. [b] Gas making and street use. [c] Railroad shipments can not be classified.
[d] Includes some Oklahoma and Louisiana crude oil. [e] Estimated.

STOCKS.

The following table gives the stocks of petroleum in the United States in 1909, by fields:

Stocks, runs, and deliveries of petroleum in the United States in 1909, by fields, in barrels.

Field.	Gross stocks, December 31, 1908.	Runs from wells sold or used in 1909.	Deliveries in 1909.	Gross stocks, December 31, 1909.
Appalachian	8,675,818	26,535,844	53,921,153	10,283,617
Lima-Indiana	6,411,186	8,211,443	13,284,766	6,432,408
Illinois	25,637,482	30,898,339	14,703,817	29,490,190
Kansas and Oklahoma	[a] 47,393,049	49,122,982	46,190,831	[b] 49,629,362
Louisiana	322,257	3,059,531	2,732,308	669,272
Texas	[c] 2,647,177	9,534,467	10,066,309	[c] 2,115,297
California	[d] 1,839,461	54,433,010	54,709,087	[d] 1,563,384
Other	3,675	338,658	338,917	3,416
Total in 1909	92,930,105	182,134,274	195,947,188	100,186,946
Total in 1908	....	178,527,355	193,459,209	....
Total in 1907	....	166,095,335	172,014,023	....

[a] In addition it is estimated that 7,500,000 barrels were held in producers' storage and refiners' reserve.
[b] In addition it is estimated that 6,750,000 barrels were held in producers' storage and refiners' reserve.
[c] In addition to this some oil was held in producers' storage and refiners' reserve.
[d] Field stock held by producers and do not include stocks held by pipe-line companies, which it is estimated amounted to some 18,000,000 barrels at the close of 1909.

In the following tables are given the grades of all stocks of crude petroleum held in the oil fields of the United States at the close of 1908 and 1909, and the grades of stocks of crude oil held by the eastern pipe lines at the close of each month of the same year.

Grades of all stocks of petroleum held in the United States December 31, 1908 and 1909, by fields, in barrels.

Kind of oil.	Quantity.	
	1908.	1909.
Pennsylvania	3,829,124	5,510,410
Lima	3,824,496	4,011,233
Illinois	29,209,745	32,343,887
Kentucky	312,390	428,390
Kansas and Oklahoma	50,941,780	53,541,657
Louisiana	322,257	669,272
Texas	2,647,177	2,115,297
California	1,839,461	1,563,384
Other	3,675	3,416
Total	92,930,105	100,186,946

Grades of gross stocks of petroleum held by the eastern pipe lines at the close of each month in 1908 and 1909, in barrels.

Month.	1908.					
	Pennsylvania.	Lima.	Illinois.	Kentucky.	Kansas.	Total.
January						12,835,198
February	3,036,059	4,699,795	2,086,609	310,771	2,815,878	12,949,112
March	3,074,634	4,567,612	2,919,608	334,913	2,615,961	13,512,728
April	3,092,554	4,653,599	3,189,075	324,724	2,571,254	13,831,206
May	3,262,774	4,279,366	2,912,737	307,149	2,954,770	13,716,796
June	3,556,125	4,151,247	3,049,094	224,035	2,777,811	13,758,312
July	3,561,856	4,110,690	3,452,404	278,550	2,960,789	14,364,289
August	3,566,999	3,709,929	3,203,173	302,363	3,525,776	14,308,240
September	3,476,693	3,547,627	2,726,598	254,684	4,114,869	14,120,471
October	3,209,015	3,481,262	2,852,588	298,708	4,251,463	14,093,036
November	3,052,538	3,612,152	3,297,260	290,982	3,859,430	14,112,362
December	3,306,894	3,619,819	3,572,263	311,590	3,548,731	14,359,297

Month.	1909.					
	Pennsylvania.	Lima.	Illinois.	Kentucky.	Kansas.	Total.
January	3,603,685	3,909,003	3,325,613	314,868	3,829,793	14,982,962
February	3,874,033	3,903,060	3,389,803	278,140	3,694,064	15,139,100
March	3,988,813	4,035,963	3,726,418	282,995	3,109,693	15,143,882
April	4,244,380	4,027,988	3,580,142	224,042	3,497,657	15,574,209
May	4,608,354	4,304,205	2,894,212	367,473	3,850,338	16,024,582
June	4,888,960	4,485,258	2,922,182	417,128	3,807,378	16,520,906
July	5,154,631	4,382,448	3,408,835	447,774	3,885,706	17,279,394
August	5,243,639	4,262,410	4,071,808	434,347	3,933,498	17,945,702
September	5,293,191	4,015,354	3,646,595	406,585	4,426,228	17,787,953
October	5,133,679	3,961,912	2,913,877	430,491	4,775,371	17,215,330
November	5,334,714	3,950,803	2,854,051	412,110	4,612,450	17,164,128
December	5,384,904	3,827,694	3,351,947	423,694	3,912,295	16,900,534

WELL RECORD.

The following table gives the well record for the United States for 1909, by fields:

Well record in the United States in 1909, by fields.

Field.	Wells completed.				Initial daily production, in barrels.	
	Oil.	Gas.	Dry.	Total.	Total.	Average per well.
Appalachian	6,246	466	1,819	8,531	83,135	13.3
Pennsylvania and New York	3,560	....	663	4,223	11,333	3.2
Southeastern Ohio	1,460	109	711	2,280	26,152	17.9
West Virginia	1,134	357	366	1,857	43,464	38.3
Kentucky	92	....	79	171	2,186	23.8
Lima-Indiana	1,006	....	171	1,177	11,981	11.9
Lima, Ohio	787	....	85	872	8,118	10.3
Indiana	219	....	86	305	3,863	17.6
Illinois	2,593	....	558	3,151	89,756	34.6
Mid-Continent	2,927	554	531	4,012	208,940	71.4
Kansas	69	383	106	558	1,309	19.0
Oklahoma	2,742	157	380	3,279	206,454	75.3
Northern Texas	116	14	45	175	1,177	10.8
Gulf	471	28	222	721	54,750	116.2
Coastal Texas	368	9	161	538	33,300	89.7
Louisiana	103	19	61	183	21,450	210.3
California	578	....	60	638	....	....
Colorado	31	....	39	70	....	....
Other	23	....	4	27	....	....
Total	13,875	1,048	3,404	18,327	....	....

APPALACHIAN OIL FIELD.

PRODUCTION.

The following table gives the production of petroleum in the Appalachian oil field during the year 1909, by States and months:

Production of the Appalachian oil field, by States and months, in 1909, in barrels.

Month.	Pennsylvania.	New York.	Southeastern Ohio.	West Virginia.	Kentucky.	Total.
January	759,178	95,270	339,951	735,379	59,799	1,989,577
February	704,391	89,526	333,792	722,045	56,355	1,906,109
March	822,600	100,008	401,083	851,002	63,085	2,237,778
April	784,155	96,249	388,865	833,432	55,681	2,158,382
May	818,359	98,490	390,884	829,833	57,065	2,194,631
June	820,155	99,905	376,480	870,909	53,522	2,220,971
July	792,327	96,247	457,921	904,745	55,414	2,306,654
August	786,563	93,900	414,599	923,438	54,777	2,273,277
September	774,750	93,583	415,325	950,188	54,221	2,288,067
October	758,779	90,382	417,112	997,295	46,330	2,309,898
November	765,504	91,058	406,158	1,016,738	41,772	2,321,230
December	712,642	90,279	375,266	1,110,088	40,995	2,329,270
Total	9,299,403	1,134,897	4,717,436	10,745,092	639,016	26,535,844

The production of petroleum in the Appalachian oil field from 1859 to 1909, inclusive, is given in the following table:

Production of petroleum in the Appalachian field, 1859–1909, in barrels.

Year.	Production.	Per cent of total production.	Increase (+) or decrease (−) from previous year.	Yearly average price per barrel.[a]	Year.	Production.	Per cent of total production.	Increase (+) or decrease (−) from previous year.	Yearly average price per barrel.[a]
1859	2,000	100	....	$16.00	1885	21,533,785	98.51	−2,422,653	$0.87 7/8
1860	500,000	100	+ 498,000	9.59	1886	26,549,827	94.60	+5,016,042	.71 1/4
1861	2,113,609	100	+1,613,609	.49	1887	22,878,241	80.90	−3,671,586	.66 3/4
1862	3,056,690	100	+ 943,081	1.05	1888	16,941,397	61.36	−5,936,844	.87 5/8
1863	2,611,309	100	+ 445,381	3.15	1889	22,355,225	63.57	+5,413,828	.94 1/8
1864	2,116,109	100	− 495,200	8.06	1890	30,073,307	65.63	+7,718,082	.86 3/4
1865	2,497,700	100	+ 381,591	6.59	1891	35,848,777	66.03	+5,775,470	.67
1866	3,597,700	100	+1,100,000	3.74	1892	33,432,377	66.19	−2,416,400	.55 5/8
1867	3,347,300	100	− 250,400	2.41	1893	31,365,890	64.76	−2,066,487	.64
1868	3,646,117	100	+ 298,817	3.62 1/2	1894	30,783,424	62.38	− 582,466	.83 7/8
1869	4,215,000	100	+ 568,883	5.63 3/4	1895	30,960,639	58.54	+ 177,215	1.35 7/8
1870	5,260,745	100	+1,045,745	3.86	1896	33,971,902	55.73	+3,010,263	1.17 7/8
1871	5,205,234	100	− 55,511	4.34	1897	35,230,271	58.25	+1,258,369	.78 5/8
1872	6,293,194	100	+1,087,960	3.64	1898	31,717,425	57.29	−3,512,846	.91 1/8
1873	9,893,786	100	+3,600,592	1.83	1899	33,068,356	57.94	+1,350,931	1.29 3/8
1874	10,926,945	100	+1,033,159	1.17	1900	36,295,433	57.05	+3,227,077	1.35 1/4
1875	8,787,514	100	−2,139,431	1.35	1901	33,618,171	48.45	−2,677,262	1.21
1876	9,120,669	99.87	+ 333,155	2.56 1/4	1902	32,018,787	36.07	−1,599,384	1.23 3/4
1877	13,337,363	99.90	+4,216,694	2.42	1903	31,558,248	31.41	− 460,539	1.59
1878	15,381,641	99.90	+2,044,278	1.19	1904	31,408,567	26.83	− 149,681	1.62 3/4
1879	19,894,288	99.90	+4,512,647	.85 7/8	1905	29,366,960	21.80	−2,041,607	1.39 3/8
1880	26,245,571	99.85	+6,351,283	.94 1/2	1906	27,741,472	21.93	−1,625,488	1.59 3/4
1881	27,561,376	99.64	+1,315,805	.85 7/8	1907	25,342,137	15.26	−2,399,335	1.74 1/2
1882	30,221,261	99.58	+2,659,885	.78 1/8	1908	24,945,517	13.97	− 396,620	1.78
1883	23,306,776	99.39	−6,914,485	1.05 3/4	1909	26,535,844	14.57	+1,590,327	1.64 5/8
1884	23,956,438	98.92	+ 649,662	.83 1/2					

[a] Price of oil of "Pennsylvania" grade as given by Seep Purchasing Agency.

In the following table is shown the production of the Appalachian field, by States, in the years 1908 and 1909, with the increase and decrease for each State and the percentage of increase or decrease as compared with the previous year:

Production of petroleum in the Appalachian field in 1908 and 1909, by States, showing increase or decrease, in barrels.

State.	Production.		Increase.	Decrease.	Per cent.	
	1908.	1909.			Increase.	Decrease.
Pennsylvania	9,424,325	9,299,403	....	124,922	....	1.33
New York	1,160,128	1,134,897	....	25,231	....	2.17
Southeastern Ohio	4,110,121	4,717,436	607,315	....	14.78	....
West Virginia	9,523,176	10,745,092	1,221,916	....	12.83	....
Kentucky	727,767	639,016	....	88,751	....	12.19
Total	24,945,517	26,535,844	1,590,327	....	6.38	....

In the following table are given the quantity, value, and price per barrel of the oil produced in the Appalachian field during the years 1908 and 1909, by States:

Quantity and value at wells of petroleum produced in the Appalachian field in 1908 and 1909, by States.

State.	1908.			1909.		
	Quantity, in barrels.	Value.	Price per barrel.	Quantity, in barrels.	Value.	Price per barrel.
Pennsylvania	9,424,325	$16,881,194	$1.791	9,299,403	$15,424,554	$1.659
New York	1,160,128	2,071,533	1.786	1,134,897	1,878,217	1.655
Southeastern Ohio	4,110,121	7,316,617	1.780	4,717,436	7,773,880	1.648
West Virginia	9,523,176	16,911,865	1.776	10,745,092	17,642,283	1.642
Kentucky	727,767	706,811	.971	639,016	518,299	.811
Total	24,945,517	43,888,020	1.759	26,535,844	43,237,233	1.629

Production and value of petroleum in the Appalachian field, 1900–1909, by States, in barrels.

Year.	Pennsylvania.		New York.		Southeastern Ohio.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1900	13,258,202	$18,088,016	1,300,925	$1,759,501	5,478,372	$7,418,297
1901	12,625,378	15,430,609	1,206,618	1,460,008	5,471,790	6,621,959
1902	12,063,880	15,266,093	1,119,730	1,530,852	5,136,501	6,473,287
1903	11,355,156	18,170,881	1,162,978	1,849,135	5,586,433	8,883,182
1904	11,125,762	18,222,242	1,113,264	1,811,837	5,526,571	8,995,386
1905	10,437,195	14,653,278	1,117,582	1,557,630	5,016,736	6,992,885
1906	10,256,893	16,596,943	1,243,517	1,995,377	4,906,579	7,839,359
1907	9,999,306	17,579,706	1,212,300	2,127,748	4,214,391	7,344,408
1908	9,424,325	16,881,194	1,160,128	2,071,533	4,110,121	7,316,617
1909	9,299,403	15,424,554	1,134,897	1,878,217	4,717,436	7,773,880

Year.	West Virginia.		Kentucky-Tennessee.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1900	16,195,675	$21,922,702	[a] 62,259	$46,782	36,295,433	$49,235,298
1901	14,177,126	17,172,724	137,259	111,527	33,618,171	40,796,827
1902	13,513,345	17,040,317	185,331	141,044	32,018,787	40,451,593
1903	12,899,395	20,516,532	554,286	486,083	31,558,248	49,905,813
1904	12,644,686	20,583,781	998,284	984,938	31,408,567	50,598,184
1905	11,578,110	16,132,631	1,217,337	943,211	29,366,960	40,279,635
1906	10,120,935	16,170,293	1,213,548	1,031,629	27,741,472	43,633,601
1907	9,095,296	15,852,428	820,844	862,396	25,342,137	43,766,686
1908	9,523,176	16,911,865	[b] 727,767	706,811	24,945,517	43,888,020
1909	10,745,092	17,642,283	[b] 639,016	518,299	26,535,844	43,237,233

[a] Includes 41,405 barrels sold in 1900 but produced in previous years.
[b] No production in Tennessee recorded.

In the two following tables is given the production of petroleum in the Appalachian field from 1903 to 1909—in the first by months and in the second by days:

Production of petroleum in the Appalachian oil field, 1903–1909, by months and years, in barrels.

Month.	1903.	1904.	1905.	1906.	1907.	1908.	1909.
January	2,726,634	2,377,630	2,368,186	2,346,346	2,064,855	1,968,724	1,989,577
February	2,353,281	2,294,922	2,207,659	2,070,728	1,938,474	1,873,646	1,906,109
March	2,759,807	2,719,887	2,685,538	2,397,601	2,186,092	2,105,483	2,237,778
April	2,691,431	2,599,224	2,445,161	2,326,650	2,169,518	2,072,861	2,158,382
May	2,681,586	2,743,881	2,685,829	2,473,788	2,254,810	2,120,427	2,194,631
June	2,731,722	2,700,030	2,570,383	2,383,010	2,082,385	2,182,340	2,220,971
July	2,758,308	2,697,037	2,434,710	2,406,191	2,245,920	2,172,802	2,306,654
August	2,628,708	2,822,017	2,523,737	2,437,028	2,155,226	2,098,144	2,273,277
September	2,633,513	2,668,124	2,358,897	2,198,899	2,021,582	2,120,175	2,288,067
October	2,664,422	2,606,321	2,376,013	2,329,121	2,138,189	2,103,249	2,309,898
November	2,374,373	2,558,764	2,268,847	2,180,492	1,947,011	1,938,239	2,321,230
December	2,554,463	2,620,730	2,442,000	2,191,618	2,138,075	2,189,427	2,329,270
Total	31,558,248	31,408,567	29,366,960	27,741,472	25,342,137	24,945,517	26,535,844

Average daily production of petroleum in the Appalachian oil field each month, 1903–1909, by months and years, in barrels.

Month.	1903.	1904.	1905.	1906.	1907.	1908.	1909.
January	87,956	76,698	76,393	75,689	66,608	63,507	64,180
February	84,046	79,135	78,845	73,955	69,231	64,608	68,075
March	89,026	87,738	86,630	77,342	70,519	67,919	72,186
April	89,714	86,641	81,505	77,555	72,317	69,095	71,946
May	86,503	88,512	86,640	79,798	72,736	68,401	70,795
June	91,057	90,001	85,679	79,434	69,413	72,745	74,032
July	88,978	87,001	78,539	77,619	72,449	70,090	74,408
August	84,797	91,033	81,411	78,614	69,523	67,682	73,332
September	87,784	88,937	78,630	73,297	67,386	70,673	76,269
October	85,949	84,075	76,646	75,133	68,974	67,847	74,513
November	79,146	85,292	75,628	72,683	64,903	64,608	77,374
December	82,402	84,540	78,774	70,697	68,970	70,627	75,138
Average	86,461	85,816	80,457	76,004	69,430	68,157	72,701

PIPE-LINE STATISTICS IN THE APPALACHIAN FIELD.

In the following tables are given the pipe-line runs for the principal lines in this field, together with their deliveries for each month in 1909, and the stocks held by these lines at the close of each month for the same period:

Pipe-line runs in the Appalachian oil field, 1909, by lines and months, in barrels.

Month.	National Transit.	Southwest.	Eureka.	Cumberland.	New York Transit.	Tidewater.
January	362,598	131,943	665,204	51,598	18,489	127,612
February	329,283	132,999	658,593	49,157	17,911	116,019
March	385,826	154,756	781,629	54,437	19,077	134,304
April	377,579	142,993	768,020	50,903	18,155	125,578
May	388,690	142,651	762,024	54,258	18,641	139,480
June	388,007	150,689	810,769	50,512	19,713	134,601
July	371,543	139,535	844,873	52,281	17,651	131,467
August	365,191	140,367	865,710	53,531	17,894	128,074
September	355,780	141,458	891,423	52,989	17,881	125,125
October	349,729	131,526	939,339	45,143	17,642	123,176
November	351,296	132,945	959,328	40,738	16,439	125,578
December	311,752	133,224	1,050,361	39,959	16,898	120,033
Total	4,337,274	1,675,086	9,997,273	595,506	216,391	1,531,047

Pipe-line runs in the Appalachian oil field, 1909, by lines and months, in barrels—Contd.

Month.	Producers and Refiners.	Emery.	Buckeye Macksburg.	Franklin.	Other pipe lines.	Total.
January	209,389	26,795	251,655	3,169	131,125	1,989,577
February	199,877	25,279	254,367	3,108	119,516	1,906,109
March	228,310	30,583	306,055	3,933	138,868	2,237,778
April	209,116	28,252	304,583	3,837	129,366	2,158,382
May	207,889	31,938	311,701	3,741	133,618	2,194,631
June	203,707	30,323	295,868	3,520	133,262	2,220,971
July	208,181	29,740	375,929	3,735	131,719	2,306,654
August	205,579	30,273	334,466	4,393	127,799	2,273,277
September	202,768	29,898	336,211	3,442	131,092	2,288,067
October	200,577	29,374	341,734	4,437	127,221	2,309,898
November	196,083	30,547	332,275	3,936	132,065	2,321,230
December	188,291	27,822	307,628	2,425	130,877	2,329,270
Total	2,459,767	350,824	3,762,472	43,676	1,566,528	26,535,844

Pipe-line deliveries in the Appalachian oil field in 1909, by lines and months, in barrels.

Month.	National Transit.	Southwest.	Eureka.	Cumberland.	Southern.	Crescent.	New York Transit.
January	1,614,034	121,602	44,480	3,846	588,807	171,854	1,431,666
February	1,306,502	99,962	28,721	2,147	533,653	134,730	1,215,526
March	1,700,556	125,853	40,501	3,024	564,184	141,855	1,762,402
April	1,580,280	115,602	17,053	1,443	586,124	155,202	1,430,693
May	1,753,940	114,140	22,168	2,811	584,201	174,320	1,070,637
June	1,736,205	114,621	50,684	3,530	592,153	73,835	1,448,256
July	1,621,152	115,765	38,719	3,600	581,042	6,569	1,146,790
August	1,695,936	115,415	44,706	4,671	629,851	86,327	1,138,779
September	1,851,159	123,722	48,656	3,969	569,630	137,343	1,308,812
October	1,801,564	126,850	73,697	1,446	570,567	232,136	1,264,109
November	1,495,401	125,870	71,647	1,476	595,562	113,636	1,480,228
December	1,968,111	122,664	80,313	2,764	496,992	117,498	1,564,517
Total	20,124,840	1,422,066	561,345	33,727	6,892,766	1,545,305	16,262,415

Month.	Tidewater.[a]	Producers and Refiners.	Emery.	United States.	Buckeye Macksburg.	Franklin.	Other pipe lines.[b]	Total.[a]
January	300,109	235,157	25,700	65,913	6,061	7,662	130,885	4,746,776
February	263,631	199,125	23,940	58,588	4,842	2,373	130,884	4,004,624
March	326,597	252,087	31,289	98,838	1,157	144	130,885	5,179,372
April	283,067	211,840	30,459	61,852	1,501	....	130,884	4,606,000
May	318,170	195,077	32,601	69,127	4,945	....	130,885	4,473,022
June	321,464	193,574	31,653	68,252	4,060	....	130,885	4,769,172
July	214,120	235,314	30,601	74,350	4,465	....	130,884	4,203,371
August	304,976	207,798	27,905	78,427	5,461	2	130,885	4,471,139
September	174,415	219,085	29,415	89,824	4,925	490	130,884	4,692,329
October	176,907	191,168	30,059	70,804	7,896	3,136	130,884	4,681,223
November	273,708	193,846	33,218	44,985	4,904	11,770	130,884	4,577,135
December	298,333	219,129	27,085	56,598	5,950	12,137	130,884	5,102,975
Total	3,255,497	2,553,200	353,925	837,558	56,167	37,714	1,570,613	[c]53,921,153

[a] Includes also deliveries of Illinois crude oil. [b] Averaged. [c] Excludes Illinois petroleum.

Gross stocks held by pipe lines in the Appalachian oil field at close of each month, in 1909, in barrels.

Month.	National Transit.	South-west.	Eureka.[a]	Cumber-land.	South-ern.	Crescent.	New York Transit.	Tide-water.[a]
January	1,149,329	868,237	1,326,974	217,759	774,898	81,944	1,778,014	437,859
February	1,251,174	1,064,863	1,301,113	192,639	751,944	84,827	2,015,588	437,885
March	1,228,885	1,060,289	1,252,500	206,772	776,749	93,217	1,779,714	441,246
April	1,462,563	925,275	1,390,381	224,042	753,325	81,011	1,941,088	428,086
May	1,699,481	783,187	1,233,135	278,346	819,510	63,700	2,312,434	546,778
June	1,807,524	945,066	1,293,141	327,637	822,539	100,081	2,526,057	614,213
July	1,980,290	1,091,982	1,489,643	357,128	757,035	146,336	2,662,757	715,352
August	2,090,395	1,012,744	1,289,914	335,792	825,076	136,845	2,803,133	698,058
September	1,870,709	1,022,485	1,348,680	341,196	842,535	151,508	2,694,725	787,556
October	1,748,874	1,138,165	1,256,320	338,801	867,226	72,590	2,705,193	848,407
November	1,983,455	958,229	1,416,755	346,226	833,649	1,042,293	2,710,523	864,707
December	1,694,486	990,306	1,389,608	339,955	908,383	137,411	2,637,594	[b] 854,565

Month.	Northern.	Produc-ers and Refiners.	Emery.	United States.	Buckeye Macks-burg.	Franklin.	Other pipe lines.	Total.
January	1,337,198	237,874	14,529	118,011	259,634	44,939	....	....
February	1,183,232	238,626	15,869	88,816	279,716	44,950	....	....
March	1,245,874	252,087	15,162	59,366	301,363	48,301	....	....
April	956,782	249,394	12,955	63,602	290,980	51,557	....	....
May	1,043,299	262,206	12,292	67,182	317,830	54,117	....	....
June	1,104,299	272,362	10,962	74,237	295,868	57,657	....	....
July	1,111,727	245,254	10,100	81,197	284,504	60,810	....	....
August	1,300,780	243,090	12,469	73,412	289,027	64,622	....	....
September	1,403,332	226,806	12,952	56,765	266,175	66,994	....	....
October	1,199,720	239,746	12,268	46,018	252,913	67,714	....	....
November	1,024,976	242,002	9,597	60,418	264,466	59,299	....	....
December	1,145,500	211,355	10,333	66,921	265,248	49,002	81,200	10,283,617

[a] Includes also stocks of Illinois petroleum. [b] Includes 498,250 barrels of Illinois petroleum.

PRICES OF APPALACHIAN OIL.

The following table shows the range of prices paid by the Seep Purchasing Agency for the different grades of Appalachian oil in 1907, 1908, and 1909:

Range of prices paid at wells by the Seep Purchasing Agency for light petroleum produced in the New York, Ohio, Pennsylvania, and West Virginia oil regions during 1907, 1908, and 1909, per barrel of 42 gallons.

Date.	Pennsyl-vania and second sand, Pa.	Tiona, Pa.	Butler and Richland, Ohio.	Corning, Ohio.	Newcastle, Ohio.	Cabell, W. Va.
1907.						
January 1	$1.58	$1.68	$1.78	$1.10	$1.35	$1.18
February 11	1.63	1.73	1.78	1.12	1.37	1.20
March 9	1.68	1.78	1.78	1.14	1.39	1.22
March 13	1.78	1.78	1.78	1.14	1.39	1.22
April 12	1.78	1.78	1.78	1.14	1.22	1.22
June 1	1.78	1.78	1.78	1.14	1.22	1.32
1908.						
January 1[a]	1.78	1.78	1.78	1.14	1.22	1.32

[a] No change during the year.

Range of prices paid at wells by the Seep Purchasing Agency for light petroleum produced in the New York, Ohio, Pennsylvania, and West Virginia oil regions during 1907, 1908, and 1909, per barrel of 42 gallons—Continued.

Date.	Pennsylvania and Tiona, Pa.	Mercer black, Pa.	Corning, Ohio.	Newcastle, Ohio.	Cabell, W. Va.
1909.					
January 1	$1.78	....	$1.14	$1.22	$1.32
March 9	1.78	$1.25	1.14	1.22	1.32
May 4	1.73	1.20	1.09	1.17	1.27
May 11	1.68	1.15	1.04	1.12	1.22
June 26	1.63	1.10	.99	1.07	1.17
July 16	1.58	1.10	.94	1.02	1.12
July 20	1.58	1.05	.94	1.02	1.12
October 21	1.53	1.00	.89	.97	1.07
November 6	1.48	.95	.84	.92	1.02
December 9	1.43	.90	.79	.87	.97

In the following table is given the average price per month of the different light oils of New York, Pennsylvania, Ohio, and West Virginia during the years 1907, 1908, and 1909:

Average monthly prices of Appalachian petroleum in 1907, 1908, and 1909, per barrel.

Month.	Pennsylvania and second sand, Pennsylvania.	Tiona, Pennsylvania.	Butler and Richland, Ohio.	Corning, Ohio.	Newcastle, Ohio.	Cabell, West Virginia.
1907.						
January	$1.58	$1.68	$1.78	$1.10	$1.35	$1.18
February	1.61¼	1.71¼	1.78	1.11¼	1.36¼	1.19¼
March	1.72⅞	1.76⅝	1.78	1.13½	1.38½	1.21½
April	1.78	1.78	1.78	1.14	1.28½	1.22
May	1.78	1.78	1.78	1.14	1.22	1.22
June	1.78	1.78	1.78	1.14	1.22	1.32
July	1.78	1.78	1.78	1.14	1.22	1.32
August	1.78	1.78	1.78	1.14	1.22	1.32
September	1.78	1.78	1.78	1.14	1.22	1.32
October	1.78	1.78	1.78	1.14	1.22	1.32
November	1.78	1.78	1.78	1.14	1.22	1.32
December	1.78	1.78	1.78	1.14	1.22	1.32
Average	1.74½	1.76½	1.78	1.13⅜	1.26¼	1.27¼
1908.						
Average	1.78	1.78	1.78	1.14	1.22	1.32

Month.	Pennsylvania and Tiona, Pennsylvania.	Mercer black, Pennsylvania.	Corning, Ohio.	Newcastle, Ohio.	Cabell, West Virginia.
1909.					
January	$1.78	....	$1.14	$1.22	$1.32
February	1.78	....	1.14	1.22	1.32
March	1.78	$1.25	1.14	1.22	1.32
April	1.78	1.25	1.14	1.22	1.32
May	1.70	1.16⅞	1.06	1.14	1.24
June	1.67¼	1.14¼	1.03¼	1.11¼	1.21¼
July	1.60¼	1.08	.96¼	1.04¼	1.14¼
August	1.58	1.05	.94	1.02	1.12
September	1.58	1.05	.94	1.02	1.12
October	1.56¼	1.03¼	.92¼	1.00¼	1.10¼
November	1.49	.96	.85	.93	1.03
December	1.44⅜	.91⅜	.80⅜	.88⅜	.98⅜
Average	1.64⅝	1.09	1.00⅝	1.08⅝	1.18⅝

The average monthly and yearly prices per barrel of Pennsylvania petroleum at wells in the years 1900–1909 are given in the table following.

Monthly and yearly average prices of pipe-line certificates of Pennsylvania petroleum at wells in daily market, 1900–1909, per barrel.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average.
1900	\$1.66⅝	\$1.68	\$1.68	\$1.55	\$1.39⅜	\$1.25½	\$1.25⅝	\$1.25½	\$1.23	\$1.10⅜	\$1.06¾	\$1.08¾	\$1.35¼
1901	1.19½	1.25	1.29	1.20½	1.07⅝	1.05	1.13⅜	1.25	1.25⅜	1.30	1.30	1.21	1.21
1902	1.15	1.15	1.15	1.17½	1.20	1.20⅜	1.22	1.22	1.22	1.28⅛	1.38¼	1.49	1.23¾
1903	1.52½	1.50	1.50	1.51	1.51½	1.50	1.52½	1.56	1.57¼	1.68½	1.78¾	1.88⅜	1.59
1904	1.85	1.82	1.72⅛	1.65½	1.62	1.58⅝	1.52	1.50	1.53¾	1.56	1.58¾	1.57	1.62¾
1905	1.43⅛	1.39	1.38¼	1.32¾	1.28¾	1.27	1.27	1.27	1.35⅜	1.57½	1.59	1.58	1.39⅜
1906	1.58	1.58	1.58	1.60⅜	1.64	1.64	1.63⅝	1.58	1.58	1.58	1.58	1.58	1.59¾
1907	1.58	1.61¼	1.72⅞	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.74½
1908	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78
1909	1.78	1.78	1.78	1.78	1.70	1.67¼	1.60¼	1.58	1.58	1.56¼	1.49	1.44⅜	1.64⅝

The following table shows the range of prices of Pennsylvania crude oil each year since 1859:

Highest and lowest prices of Pennsylvania crude petroleum each year, 1859–1909, per barrel.

Year.	Highest.		Lowest.	
	Month.	Price.	Month.	Price.
1859	September	\$20.00	December	\$20.00
1860	January	20.00	do	2.00
1861	do	1.75	do	.10
1862	December	2.50	January	.10
1863	do	4.00	do	2.00
1864	July	14.00	February	3.75
1865	January	10.00	August	4.00
1866	do	5.50	December	1.35
1867	October	4.00	June	1.50
1868	July	5.75	January	1.70
1869	January	7.00	December	4.25
1870	do	4.90	August	2.75
1871	June	5.25	January	3.25
1872	October	4.55	December	2.67½
1873	January	2.75	November	.82½
1874	February	2.25	do	.62½
1875	do	1.82½	January	.75
1876	December	4.23¾	do	1.47½
1877	January	3.69⅜	June	1.53¾
1878	February	1.87½	September	.78¾
1879	December	1.28¾	June	.63⅛
1880	June	1.24⅜	April	.71¼
1881	September	1.01¼	July	.72½
1882	November	1.37	do	.49¼
1883	June	1.24¾	January	.83¼
1884	January	1.15⅝	June	.51¼
1885	October	1.12⅝	January	.68
1886	January	.92¼	August	.59¾
1887	December	.90	July	.54
1888	March	1.00	June	.71⅜
1889	November	1.12½	April	.79½
1890	January	1.07⅝	December	.60¾
1891	February	.81⅜	August	.50
1892	January	.64⅛	October	.50
1893	December	.80	January	.52⅞
1894	do	.95¾	do	.78½
1895	April	2.60	do	.95¼
1896	January	1.50	December	.90
1897	March	.96	October	.65
1898	December	1.19	January	.65
1899	do	1.66	February	1.13
1900	January	1.68	November	1.05
1901	January, September	1.45	May	.80
1902	December	1.54	January, February, March	1.15
1903	do	1.90	January, February, March, April, May, June, July.	1.50
1904	January	1.85	July, December	1.50
1905	October	1.61	May	1.27
1906	April, May, June, July	1.64	January, February, March, April, August, September, October, November, December.	1.58
1907	March to December, inclusive.	1.78	January	1.58
1908	No change	1.78	No change	1.78
1909	January, February, March	1.78	December	1.43

PENNSYLVANIA AND NEW YORK.

The decline in Pennsylvania and New York in 1909 was very slight, much less than the average for past years. This was due to better results from many small producers rather than from any large new developments. The price per barrel of Pennsylvania grade was reduced from $1.78 in May to $1.43 in December, with corresponding cuts in the price of other Appalachian oils. The average price for the year was $1.655, a reduction from $1.791 in 1908.

The petroleum developments of Pennsylvania in 1909 were generally limited to well-defined oil-producing regions. Early in the year great activity was centered in the Venango district, but small wells were the result. Some little excitement was created at Bradford, McKean County, in March, and many wells were drilled on adjoining lands as well as on town lots. In May quite a surprise was occasioned in the old Pennsylvania region near Bruin, Butler County, where a 50-barrel producer was found, and a revival of development work in many of the older fields of Allegheny, Armstrong, Butler, and Clarion Counties began. Some new developments in Washington County added a small strip of territory to this field. The best that could be found in the new developments in Beaver County were small pumpers.

A market quotation was made by the Seep Purchasing Agency in 1909 on the black crude of Mercer County, but so far the product is small.

PRODUCTION.

The following table shows the production of petroleum in Pennsylvania and New York, 1906–1909, by months:

Production of petroleum in Pennsylvania and New York in 1906–1909, by months, in barrels.

Month.	Pennsylvania.				New York.			
	1906.	1907.	1908.	1909.	1906.	1907.	1908.	1909.
January	863,084	824,081	782,683	759,178	103,492	100,887	98,776	95,270
February	745,599	742,149	718,905	704,391	94,432	89,502	87,119	89,526
March	860,932	874,478	835,990	822,600	103,077	105,662	99,948	100,008
April	871,464	847,748	803,590	784,155	101,492	102,975	100,511	96,249
May	910,711	875,529	805,930	818,359	110,492	107,406	97,365	98,490
June	884,651	826,192	819,020	820,155	105,964	98,809	99,954	99,905
July	871,792	900,025	806,003	792,327	105,837	106,231	99,338	96,247
August	887,274	842,609	781,988	786,563	109,169	102,093	95,754	93,900
September	822,898	799,053	786,963	774,750	101,130	98,236	96,299	93,583
October	881,790	852,446	781,001	758,779	106,621	103,308	98,556	90,382
November	836,245	779,009	710,246	765,504	103,749	96,772	89,345	91,058
December	820,453	835,987	792,006	712,642	98,062	100,419	97,163	90,279
Total	10,256,893	9,999,306	9,424,325	9,299,403	1,243,517	1,212,300	1,160,128	1,134,897

WELL RECORD.

The following tables give the well records for Pennsylvania and New York from 1905 to 1909, inclusive:

Number of wells completed in the Pennsylvania and New York oil fields, 1905–1909, by districts.

District.	Completed.					Dry.					Productive.				
	1905	1906	1907	1908	1909	1905	1906	1907	1908	1909	1905	1906	1907	1908	1909
Bradford	292	332	305	359	571	56	35	37	44	36	236	297	268	315	535
Allegany	626	635	581	473	459	78	73	89	66	40	548	562	492	407	419
Middle	509	674	563	620	506	119	123	136	89	65	390	551	427	531	441
Venango and Clarion	1,396	1,905	1,997	1,841	1,881	216	253	217	201	199	1,180	1,652	1,780	1,640	1,682
Butler and Armstrong	449	475	435	520	487	162	161	164	204	178	287	314	271	316	309
Southwest Pennsylvania	449	451	451	347	319	210	161	205	153	145	239	290	246	194	174
Total	3,721	4,472	4,332	4,160	4,223	841	806	848	757	663	2,880	3,666	3,484	3,403	3,560

Number of wells completed in the Pennsylvania and New York oil fields, 1905–1909, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1905	234	143	179	293	322	351	337	326	387	373	420	356	3,721
1906	322	286	246	279	430	457	455	439	412	416	392	338	4,472
1907	272	201	218	293	405	431	436	432	447	453	429	315	4,332
1908	241	146	207	324	337	428	417	414	455	434	405	352	4,160
1909	325	298	260	370	436	448	413	384	400	274	368	247	4,223

Number of dry holes drilled in the Pennsylvania and New York oil fields, 1905–1909, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1905	55	39	56	81	69	78	82	72	92	73	77	67	841
1906	64	60	42	54	64	64	79	76	75	73	82	73	806
1907	58	43	51	62	67	85	87	90	88	75	74	68	848
1908	65	27	56	59	48	76	61	72	76	61	86	70	757
1909	57	43	33	53	62	57	54	76	62	59	52	55	663

Total and average initial daily production of new wells in the Pennsylvania and New York oil fields, 1905–1909, by districts, in barrels.

District.	Total initial production.					Average initial production per well.				
	1905.	1906.	1907.	1908.	1909.	1905.	1906.	1907.	1908.	1909.
Bradford	888	867	632	874	1,345	3.76	2.92	2.36	2.77	2.51
Allegany	1,531	1,547	1,147	806	815	2.79	2.75	2.33	1.98	1.94
Middle	1,115	1,833	1,378	1,257	977	2.86	3.33	3.23	2.37	2.22
Venango and Clarion	3,004	5,717	5,779	4,052	4,573	2.54	3.46	3.25	2.47	2.72
Butler and Armstrong	2,938	1,688	1,579	1,532	2,493	10.24	5.37	5.83	4.85	8.07
Southwest Pennsylvania	2,313	4,770	2,636	1,383	1,130	9.68	16.45	10.71	7.13	6.49
Total	11,789	16,422	13,151	9,904	11,333	4.09	4.48	3.77	2.91	3.18

Total initial daily production of new wells in the Pennsylvania and New York oil fields 1905–1909, by months, in barrels.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1905	780	417	459	723	1,709	1,314	923	970	1,093	1,223	1,192	986	11,789
1906	1,046	1,058	957	1,488	1,537	2,156	1,612	1,400	1,551	1,282	1,268	1,067	16,422
1907	1,024	802	753	1,134	1,060	1,176	1,822	961	1,156	1,187	1,256	820	13,151
1908	523	396	476	746	816	960	1,119	1,114	1,013	1,029	964	748	9,904
1909	869	785	608	930	1,084	1,027	1,011	1,148	1,046	1,082	991	752	11,333

WEST VIRGINIA.

PRODUCTION.

In the following table is given the production of petroleum in West Virginia in the years 1905 to 1909, by months:

Total production of petroleum in West Virginia, 1905–1909, by months, in barrels.

Month.	1905.	1906.	1907.	1908.	1909.
January	940,709	832,628	687,251	697,040	735,379
February	923,632	752,399	695,616	700,103	722,045
March	1,093,107	897,277	771,814	770,689	851,002
April	970,540	833,514	770,274	779,089	833,432
May	1,078,884	923,039	821,554	823,144	829,833
June	1,026,569	872,138	747,071	870,289	870,909
July	952,919	917,879	812,437	864,877	904,745
August	996,356	906,522	785,620	815,242	923,438
September	911,583	777,682	734,077	803,139	950,188
October	901,944	833,781	765,671	795,539	997,295
November	859,791	762,915	696,694	739,605	1,016,738
December	922,076	811,161	807,217	864,420	1,110,088
Total	11,578,110	10,120,935	9,095,296	9,523,176	10,745,092

The quantity and value of petroleum produced in West Virginia from 1900 to 1909, inclusive, are shown in the following table:

Quantity and value of petroleum produced in West Virginia, 1900–1909.

Year.	Regular crude.			Lubricating crude.			Total.		
	Quantity.	Value.	Price per barrel.	Quantity.	Value.	Price per barrel.	Quantity.	Value.	Price per barrel.
	Barrels.			*Barrels.*			*Barrels.*		
1900	16,176,757	$21,879,064	$1.35¼	18,918	$43,638	$2.31	16,195,675	$21,922,702	$1.353
1901	14,164,662	17,139,241	1.21	12,464	33,483	2.69	14,177,126	17,172,724	1.211
1902	13,498,685	17,006,469	1.26	14,660	33,848	2.31	13,513,345	17,040,317	1.261
1903	12,893,079	20,499,996	1.59	6,316	16,536	2.62	12,899,395	20,516,532	1.59
1904	12,636,253	20,557,556	1.627	8,433	26,225	3.11	12,644,686	20,583,781	1.628
1905	11,573,545	16,117,816	1.393	4,565	14,815	3.25	11,578,110	16,132,631	1.393
1906	10,111,647	16,138,811	1.596	9,288	31,482	3.39	10,120,935	16,170,293	1.598
1907	9,089,839	15,834,714	1.74	5,457	17,714	3.25	9,095,296	15,852,428	1.743
1908	9,519,875	16,902,968	1.775	3,301	8,897	2.70	9,523,176	16,911,865	1.776
1909	10,742,026	17,634,335	1.642	3,066	7,948	2.59	10,745,092	17,642,283	1.642

WELL RECORD.

The following tables give the well records for West Virginia from 1905 to 1909, inclusive:

Number of wells completed in West Virginia in 1909, by districts and months.

Month.	Brooke County.	Burning Springs.	Cabell County.	Calhoun County.	Hancock County.	Lincoln County.	Mannington.	Marshall County.	Pleasants County.	Ritchie County.	Roane County.	Sistersville.	Wetzel and Tyler Counties.	Wood County.	Miscellaneous.	Total.
January	14	4	....	3	3	24	18	2	13	14	11	1	13	8	2	130
February	12	1	1	2	4	27	27	3	10	15	10	2	13	14	3	144
March	8	2	....	2	4	29	41	....	9	13	9	5	7	11	3	143
April	12	9	1	5	1	27	24	1	10	17	16	3	7	5	2	140
May	4	6	2	4	....	29	31	1	12	11	14	3	9	4	1	131
June	7	7	2	4	2	28	34	2	14	13	18	4	10	10	....	155
July	9	2	3	3	1	25	44	1	4	10	18	3	14	13	1	151
August	3	5	2	4	3	26	51	....	11	15	16	7	13	10	2	168
September	8	8	....	2	2	30	49	....	13	17	19	11	10	10	3	182
October	5	8	2	6	2	28	44	....	17	13	24	3	10	7	2	171
November	7	....	1	3	2	26	58	1	15	10	26	4	17	7	1	178
December	8	8	....	1	....	18	45	....	14	15	27	4	14	7	3	164
Total	97	60	14	39	24	317	466	11	142	163	208	50	137	106	23	1,857

Number of wells completed in West Virginia, 1905–1909, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1905	124	141	147	154	156	137	143	117	148	126	138	133	1,664
1906	113	136	116	109	108	102	119	147	110	129	117	128	1,434
1907	84	90	98	124	135	112	104	142	112	99	104	110	1,314
1908	89	101	85	98	115	113	119	136	134	117	124	116	1,347
1909	130	144	143	140	131	155	151	168	182	171	178	164	1,857

Number of dry holes drilled in West Virginia in 1909, by districts and months.

Month.	Brooke County.	Burning Springs.	Cabell County.	Calhoun County.	Hancock County.	Lincoln County.	Mannington.	Marshall County.	Pleasants County.	Ritchie County.	Roane County.	Sistersville.	Wetzel and Tyler Counties.	Wood County.	Miscellaneous.	Total.
January	5	1	....	....	....	7	9	....	6	6	....	1	5	2	2	44
February	4	1	1	2	3	8	16	1	3	5	5	2	7	5	3	66
March	5	....	....	....	2	8	22	....	3	3	....	3	4	3	3	56
April	5	1	1	2	1	7	14	1	3	6	3	....	4	2	2	52
May	1	....	2	2	....	8	16	....	3	3	3	1	6	1	1	47
June	1	1	2	2	....	7	22	1	5	2	1	1	6	2	....	53
July	2	1	2	2	1	5	27	1	4	3	2	1	9	5	1	66
August	2	1	2	1	2	6	31	....	2	6	1	....	9	2	2	67
September	4	1	....	....	2	6	25	....	5	4	3	3	6	3	3	65
October	1	2	....	3	....	10	24	....	4	4	6	....	4	4	2	64
November	2	....	....	1	2	6	38	....	6	2	6	1	6	3	1	74
December	3	3	....	....	....	5	20	....	7	8	9	3	7	2	2	69
Total	35	12	10	15	13	83	264	4	51	52	39	16	73	34	22	a 723

a Includes 357 wells producing gas.

Number of dry holes drilled in West Virginia, 1905–1909, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1905	46	58	58	53	54	54	54	46	67	61	59	70	680
1906	37	58	36	37	38	31	43	56	33	42	48	49	508
1907	35	36	39	54	54	39	36	48	36	38	37	40	492
1908	42	30	33	39	29	29	33	43	25	40	48	39	430
1909	44	66	56	52	47	53	66	67	65	64	74	69	723

Initial daily production of new wells completed in West Virginia in 1909, by districts and months, in barrels.

Month.	Brooke County.	Burning Springs.	Cabell County.	Calhoun County.	Hancock County.	Lincoln County.	Mannington.	Marshall County.	Pleasants County.	Ritchie County.	Roane County.	Sistersville.	Wetzel and Tyler counties.	Wood County.	Miscellaneous.	Total.
January	212	13	....	27	12	475	180	85	52	224	281	....	82	39	....	1,682
February	165	......	....	......	10	702	223	35	64	298	102	....	78	104	....	1,781
March	65	3	....	120	13	663	690	....	48	286	243	8	45	37	....	2,221
April	135	38	....	77	....	710	463	....	31	392	405	14	42	30	....	2,337
May	50	17	....	75	....	475	603	15	35	212	207	6	85	15	....	1,795
June	115	21	....	175	4	590	650	60	39	405	486	22	35	54	....	2,656
July	150	1	5	50	....	650	1,286	....	....	228	505	50	30	59	....	3,014
August	10	13	....	210	3	490	2,455	....	83	143	251	63	35	56	....	3,812
September	60	31	....	80	....	670	1,991	....	34	261	349	37	45	57	....	3,615
October	55	34	11	165	7	522	5,725	....	69	315	355	30	64	10	....	7,362
November	70	......	8	55	....	407	2,387	5	131	114	391	20	449	11	....	4,048
December	95	12	....	50	....	363	7,584	....	31	448	365	2	142	24	25	9,141
Total	1,182	183	24	1,084	49	6,717	24,237	200	617	3,326	3,940	252	1,132	496	25	43,464

Total initial daily production of new wells in West Virginia, 1905–1909, by months, in barrels.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.	Average.
1905	2,324	2,002	2,843	1,907	1,846	2,338	1,715	1,147	1,970	1,012	1,738	898	21,740	1,812
1906	888	1,166	1,930	1,844	1,813	2,101	3,378	2,311	2,075	1,630	1,655	1,744	22,535	1,878
1907	688	1,369	2,042	2,024	2,136	1,488	3,401	1,992	1,798	811	1,027	1,563	20,339	1,695
1908	2,185	2,298	1,423	2,033	3,310	3,853	2,682	2,473	2,498	1,912	1,661	1,997	28,325	2,360
1909	1,682	1,781	2,221	2,337	1,795	2,656	3,014	3,812	3,615	7,362	4,048	9,141	43,464	3,622

DEVELOPMENT IN PETROLEUM INDUSTRY.

The following account of the developments in the petroleum industry in West Virginia in 1909 has been furnished by Dr. I. C. White, State geologist of West Virginia:

The new oil and gas developments of the year 1909 have been largely confined to regions in which some development had already been made in 1908. The most sensational find of 1909 was the gusher oil well drilled by the Philadelphia Co. in the Shinnston field of Harrison County, which is supposed to have flowed at the rate of 600 barrels an hour for a few hours after the drill first penetrated the "Fifty-foot" sand in which the oil occurs. The wells in the Shinnston field have proved disappointing in staying qualities, since all of the larger ones decline very rapidly.

In the same general region of Shinnston, but farther west, some fair producing wells have been developed on Lamberts Run, Harrison County, in what is supposed to be the Fourth sand.

Nothing but small spurs from previously developed pools were found during the year (1909) in Marion, Monongalia, Wetzel, Marshall, Tyler, and Doddridge County oil fields. Some new developments were made near old ones in Ritchie and Pleasants Counties both in the "Big Injun" and the "Shallow" or Cow Run sands.

No new pools of either gas or oil have been developed in Calhoun during 1909, although the old pools have been slightly extended; but in southeastern Roane the large "Big Injun" pool of both oil and gas near Walton has been extended in nearly every direction, and a Berea gas pool has been found near Spencer. Some oil has also been found in Kanawha County on Falling Rock Creek, south from Elk River, but the wells which appear to come in the "Squaw" sand are small.

In both Upshur and Nicholas counties some good gas wells have been found much farther east than the regular gas belts of Lewis, Harrison, and Braxton counties, and they give some hope that a large area of the State just west from the mountain region which has hitherto been considered too far east for productive gas territory may yet prove to be within the zone of fair gas areas. Some new pools of both oil and gas have been developed in southern Wayne County during 1909 in the "Big Injun" sand, and the Griffithsville or Lincoln County field in the Berea grit has been greatly extended.

The West Virginia Geological Survey during the field season for 1910 has been making detailed studies and structural maps showing the underground contours over a large area. On these geological maps not only all the productive oil wells are shown but also the gas wells, dry holes, anticlines, and synclines, so that those seeking new pools of oil or gas will be greatly aided in their work. The counties of Calhoun, Wirt, and Roane, studied during 1909 by Mr. Ray V. Hennen, are all mapped in one sheet on a scale of 1 mile to the inch, showing the features mentioned above. A structural map of Pleasants, Wood, and Ritchie was in preparation by Mr. Ray V. Hennen and Mr. C. E. Krebs during the summer of 1910, after Mr. Hennen had completed the detailed geological studies in Harrison and Doddridge counties. Mr. Krebs finished the field work for a structural map of Jackson, Mason, and Putnam counties during the summer of 1910, and also of that portion of Kanawha County north from Elk River. The structural maps of these counties, added to those of Marshall, Wetzel, and Tyler published early in 1910, will cover by far the largest portion of the developed oil and gas fields of the State, and in addition the accompanying text will give detailed descriptive matter concerning the oil sands, the character of the oil and gas, and the general stratification.

KENTUCKY AND TENNESSEE.

The decline in the production of petroleum in Kentucky and Tennessee noted in previous reports continued in 1909, as shown in the following tables. In Tennessee only exploratory work was done. In 1910, upon the appointment of Mr. George H. Ashley as State geologist of Tennessee, cooperative work was begun with the United States Geological Survey with the prospect of greater interest in the development of the oil fields of the State.

In the following table is given the production of petroleum in Kentucky and Tennessee, by months, from 1905 to 1909, inclusive:

Production of petroleum in Kentucky and Tennessee, by months, 1905–1909, in barrels.

Month.	1905.	1906.	1907.	1908.	1909.
January	77,569	115,317	77,034	60,781	59,799
February	71,355	101,084	67,939	60,168	56,355
March	103,315	109,351	78,438	59,336	63,085
April	100,508	103,690	73,467	63,283	55,681
May	114,702	102,224	72,728	65,927	57,065
June	118,181	106,005	64,120	60,127	53,522
July	117,452	106,708	66,940	60,150	55,414
August	109,562	106,936	66,131	60,533	54,777
September	106,469	96,561	66,493	60,137	54,221
October	101,559	94,385	65,142	55,385	46,330
November	93,817	88,483	60,860	59,643	41,772
December	102,848	82,804	61,552	62,297	40,995
Total	1,217,337	1,213,548	820,844	[a] 727,767	[a] 639,016

[a] No production in Tennessee recorded.

Pipe-line runs in Kentucky in 1909, by districts and months, in barrels.

Month ending.	Cooper.	Elk Spring Valley.	Parmleysville.	Slickford.	Steubenville.	Total Wayne County.	Barren Creek.	Campton.	Clinton.	Irvine.	Meadow Branch.	Sinking Creek.	Ragland.	Williamsburg.	Total.
Jan. 30	5,172	3,808	14,805	6,918	5,489	36,192	1,275	7,768	187	....	....	....	3,961	500	49,883
Feb. 27	4,558	4,196	15,746	7,265	4,713	36,478	605	5,817	174	....	....	....	2,630	250	45,954
Mar. 27	4,570	4,289	16,898	7,445	4,927	38,129	1,150	6,190	....	....	....	....	1,358	420	47,247
Apr. 24	4,687	5,000	14,815	7,473	5,031	37,006	1,063	7,225	200	....	....	....	3,174	284	48,952
May 29	6,321	5,776	19,873	11,116	6,116	49,202	1,051	8,065	185	....	....	....	2,635	466	61,604
June 26	4,327	4,209	14,668	8,679	5,144	37,027	982	6,634	....	....	....	....	2,653	358	47,654
July 31	5,469	6,141	18,944	8,959	5,959	45,472	1,381	7,529	185	....	....	....	3,998	215	58,780
Aug. 28	4,031	5,118	17,726	6,671	4,292	37,838	1,055	6,876	....	....	....	....	2,750	393	48,912
Sept. 25	4,132	4,640	18,468	5,675	4,588	37,503	942	6,371	....	....	....	....	3,991	358	49,165
Oct. 30	5,155	4,762	18,441	5,784	4,746	38,888	1,044	7,716	....	186	623	....	1,662	143	50,262
Nov. 27	3,680	2,921	14,154	4,167	4,049	28,971	772	5,852	....	177	....	....	108	251	36,131
Dec. 31	5,088	2,056	15,543	4,715	5,806	33,208	1,034	7,393	....	91	....	409	3,340	216	45,691
Total	57,190	52,916	200,081	84,867	60,860	455,914	12,354	83,436	931	454	623	409	32,260	3,854	590,235

In the following table are given the dates of change and the changes in prices of the different grades of petroleum produced in Kentucky and Tennessee during the years 1907, 1908, and 1909:

Fluctuations in prices, per barrel, of Kentucky and Tennessee petroleum in 1907, 1908, and 1909.

1907.			1908.[a]			1909.[a]		
Date.	Somerset (light).	Ragland (heavy).	Date.	Somerset (light).	Ragland (heavy).	Date.	Somerset (light).	Ragland (heavy).
Jan. 1	$0.85	$0.55	Jan. 1	$1.00	$0.75	Jan. 1	$1.00	$0.65
Jan. 5	.85	.60	June 17	1.00	.70	Mar. 25	.90	.60
Feb. 11	.87	.60	July 3	1.00	.65	May 4	.85	.60
Mar. 9	.89	.62				May 11	.80	.60
Mar. 20	1.04	.62				June 26	.75	.55
Mar. 29	1.20	.62				July 16	.72	.50
Apr. 24	1.20	.70						
June 1	1.20	.75						
Oct. 29	1.10	.75						
Nov. 12	1.00	.75						

[a] No production recorded in Tennessee.

In the following table are given the average monthly prices of Kentucky and Tennessee petroleum, per barrel of 42 gallons, in the years 1905 to 1909, inclusive:

Average monthly prices, per barrel at wells, of Kentucky and Tennessee petroleum in 1905–1909.[a]

Month.	Somerset (light).					Ragland (heavy).				
	1905.	1906.	1907.	1908.	1909.	1905.	1906.	1907.	1908.	1909.
January	$0.84⅜	$0.89	$0.85	$1.00	$1.00	$0.55⅞	$0.49	$0.59⅜	$0.75	$0.65
February	.80	.89	.86¼	1.00	1.00	.53	.49	.60	.75	.65
March	.80	.89	.95½	1.00	.97¾	.53	.49	.61½	.75	.63⅞
April	.78	.89⅜	1.20	1.00	.90	.51¼	.51⅝	.63⅞	.75	.60
May	.75⅞	.91	1.20	1.00	.81⅞	.49⅞	.62	.70	.75	.60
June	.75	.91	1.20	1.00	.79¼	.49	.62	.75	.72¾	.59¼
July	.75	.90¾	1.20	1.00	.73½	.49	.61¾	.75	.65⅜	.52⅜
August	.75	.86¾	1.20	1.00	.72	.49	.59¼	.75	.65	.50
September	.78⅜	.85	1.20	1.00	.72	.49	.55	.75	.65	.50
October	.87½	.85	1.18⅞	1.00	.72	.49	.55	.75	.65	.50
November	.89¾	.85	1.03½	1.00	.72	.49	.55	.75	.65	.50
December	.89	.85	1.00	1.00	.72	.49	.55	.75	.65	.50
Average	.80⅔	.88	1.09⅛	1.00	.81⅞	.50½	.55¼	.70	.69⅞	.56¼

[a] No production recorded in Tennessee in 1908 and 1909.

WELL RECORD.

In the following tables are given the well records for Kentucky and Tennessee from 1905 to 1909, inclusive:

Number of wells completed in Kentucky and Tennessee, 1905–1909, by counties.

County.	Completed.					Dry.					Productive.				
	1905.	1906.	1907.	1908.	1909.	1905.	1906.	1907.	1908.	1909.	1905.	1906.	1907.	1908.	1909.
Bath	2	......	4	3	1	.....	.....	4	.....	1	2	......	......	3	.....
Cumberland	15	1	......	......	......	7	1	.....	.....	.....	8	......	......	......	.....
Estill	7	3	5	......	......	2	.....	1	.....	.....	5	3	4	......	.....
Fentress	1	1	......	......	......	.....	1	.....	.....	.....	1	......	......	......	.....
Floyd	1	......	......	1	1	.....	.....	.....	1	1	1	......	......	......	.....
Knox	2	......	......	......	......	2	.....	.....	.....	.....	......	......	......	......	.....
Lawrence	......	......	......	......	1	.....	.....	.....	.....	1	......	......	......	......	.....
McLean	......	......	......	......	1	.....	.....	.....	.....	1	......	......	......	......	.....
Meade	......	......	......	......	1	.....	.....	.....	.....	.....	......	......	......	......	1
Morgan	......	......	......	......	2	.....	.....	.....	.....	2	......	......	......	......	.....
Wayne	283	232	177	175	157	63	70	62	59	71	220	162	115	116	86
Wolfe	88	100	26	21	7	14	12	7	5	2	74	88	19	16	5
Other	......	......	1	......	......	.....	.....	1	.....	.....	......	......	......	......	.....
Total	399	337	213	200	171	88	84	75	65	79	311	253	138	135	92

Number of wells completed in Kentucky and Tennessee, 1905–1909, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1905	25	36	37	36	44	37	28	37	26	38	27	28	399
1906	32	33	25	36	43	26	34	29	23	21	15	20	337
1907	14	13	17	19	18	18	15	19	23	21	21	15	213
1908	13	15	20	16	21	18	18	17	15	20	11	16	200
1909	19	11	17	17	22	18	13	14	8	13	13	6	171

Number of dry holes drilled in Kentucky and Tennessee, 1905–1909, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1905	6	10	9	6	13	6	7	7	5	8	4	7	88
1906	7	8	4	10	14	6	8	3	8	6	3	7	84
1907	5	3	9	4	6	4	4	7	8	8	9	8	75
1908	5	5	7	8	5	6	5	6	6	5	2	5	65
1909	9	2	8	5	9	7	5	6	5	10	11	2	79

Total and average initial daily production of new wells in Kentucky and Tennessee, 1905–1909, by counties, in barrels.

County.	Total initial production.					Average initial production per well.				
	1905.	1906.	1907.	1908.	1909.	1905.	1906.	1907.	1908.	1909.
Bath and Rowan	7	....	....	14	....	3.5	....	....	4.7	....
Cumberland	455	....	....	....	....	56.9	....	....	....	....
Estill	42	38	40	....	....	8.4	12.7	10	....	....
Fentress	5	....	....	....	....	5.0	....	....	....	....
Meade	....	....	....	....	25	....	....	....	....	25.0
Wayne	6,469	4,569	2,121	2,167	2,111	29.4	28.2	18.4	18.7	24.5
Wolfe	2,250	1,238	250	261	50	30.4	14.1	13.2	16.3	10.0
	9,228	5,845	2,411	2,442	2,186	29.7	23.1	17.5	18.1	23.8

Total initial daily production of new wells in Kentucky and Tennessee, 1905–1909, by months, in barrels.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1905	483	365	768	694	1,231	1,520	690	895	806	718	628	430	9,228
1906	465	440	502	678	385	993	706	728	415	158	155	220	5,845
1907	110	151	250	310	141	169	141	121	348	225	225	220	2,411
1908	200	195	378	127	265	151	199	196	195	242	147	147	2,442
1909	214	128	215	100	277	177	155	502	78	10	105	225	2,186

OHIO.

Southeastern Ohio, where the petroleum pools form part of the Appalachian field, showed an increase in production. In the Lima field the usual decline more than offset the gain in the southeast, so that the total for the State declined slightly from 10,858,797 barrels in 1908 to 10,632,793 barrels in 1909.

PRODUCTION.

In the following table is given the production of petroleum in Ohio, by months and districts, for the year 1909:

Production of petroleum in Ohio in 1909, by months and districts, in barrels.

Month.	Lima.	Southeastern Ohio.	Mecca-Belden.	Total.
January	520,146	339,951	....	860,097
February	469,111	333,792	....	802,903
March	566,455	401,083	....	967,538
April	524,356	388,865	....	913,221
May	518,656	390,884	....	909,540
June	515,396	376,390	....	891,876
July	512,017	457,831	....	969,938
August	488,034	414,509	....	902,633
September	470,970	415,228	....	886,295
October	467,788	417,112	....	884,900
November	457,845	406,158	....	864,003
December	404,583	375,266	....	779,849
Total	5,915,357	4,717,069	367	10,632,793

The quantity and value of petroleum produced in Ohio from 1900 to 1909, inclusive, by districts, are shown in the following table:

Quantity and value of petroleum produced in Ohio, 1900–1909, by districts, in barrels.

Year.	Lima.		Southeastern Ohio.		Mecca-Belden.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1900	16,884,358	$16,673,304	5,476,089	$7,406,734	2,283	$11,563	22,362,730	$24,091,601
1901	16,176,293	13,911,612	5,470,850	6,619,342	940	2,617	21,648,083	20,533,571
1902	15,877,730	14,284,072	5,136,366	6,471,821	135	1,466	21,014,231	20,757,359
1903	14,893,853	17,351,339	5,585,858	8,881,514	575	1,668	20,480,286	26,234,521
1904	13,350,060	14,735,129	5,526,146	8,993,803	425	1,583	18,876,631	23,730,515
1905	11,329,924	10,061,992	5,016,646	6,991,950	90	935	16,346,660	17,054,877
1906	9,881,184	9,157,641	4,906,399	7,838,387	180	972	14,787,763	16,997,000
1907	7,993,057	7,425,480	4,214,298	7,343,943	93	465	12,207,448	14,769,888
1908	6,748,676	6,861,885	4,109,935	7,315,667	186	950	10,858,797	14,178,502
1909	5,915,357	5,451,497	4,717,069	7,771,555	367	2,325	10,632,793	13,225,377

WELL RECORD.

In the following tables are given the well records for the Southeastern Ohio oil field from 1905 to 1909, inclusive:

Number of wells completed in southeastern Ohio oil field in 1909, by districts and months.

Month.	Alliance.	Barnesville.	Cadiz.	Chester Hill.	Clear Fork.	Corning.	Graysville.	Island Creek.	Jackson Ridge.	Jerusalem.	Lewisville.	Macksburg.	Marietta.	Mingo.	New Castle.	New Matamoras	Plum Run.	Rinard Mills.	Scio.	Steubenville.	Trailrun.	Woodsfield.	Total.
January	16	...	4	6	3	32	1	14	...	2	2	16	25	4	3	4	2	4	...	...	...	7	145
February	17	...	2	9	1	30	1	12	1	...	5	12	21	8	1	4	...	3	3	...	...	7	137
March	16	...	3	4	2	38	...	12	...	4	6	16	18	4	...	6	4	2	1	...	1	13	150
April	17	...	3	13	1	33	1	21	...	3	1	15	47	6	...	4	...	3	3	...	...	8	179
May	17	...	3	19	7	46	1	...	1	4	4	16	25	4	1	5	...	1	2	20	...	5	181
June	27	...	1	21	4	59	2	...	2	3	4	20	38	3	1	9	2	2	1	25	1	7	232
July	25	...	3	17	6	80	2	...	1	3	5	14	42	2	1	3	1	2	1	34	1	7	250
August	20	...	2	24	3	62	2	...	1	4	3	25	40	7	...	3	1	...	...	36	2	5	240
September	16	...	...	24	...	62	...	...	2	3	6	19	34	7	...	3	6	2	3	23	...	6	216
October	15	1	...	17	2	47	1	...	...	2	4	27	36	2	1	4	1	...	3	13	1	2	179
November	19	...	3	12	4	62	...	...	...	7	4	17	42	3	1	3	1	1	...	15	2	5	201
December	17	1	4	12	1	47	...	...	1	...	7	26	38	3	2	3	...	...	...	2	1	5	170
Total	222	2	28	178	34	598	11	59	9	35	51	223	406	53	11	51	18	20	17	168	9	77	2,280

Number of wells completed in southeastern Ohio oil field, 1905–1909, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1905	120	99	154	133	160	147	158	164	152	145	162	135	1,729
1906	105	145	122	105	151	173	152	181	139	133	108	147	1,661
1907	104	56	68	93	122	142	131	129	117	151	119	114	1,346
1908	76	74	68	76	103	117	111	138	162	142	167	174	1,408
1909	145	137	150	179	181	232	250	240	216	179	201	170	2,280

Number of dry holes drilled in southeastern Ohio oil field in 1909, by districts and months.

Month.	Alliance.	Barnesville.	Cadiz.	Chester Hill.	Clear Fork.	Corning.	Graysville.	Island Creek.	Jackson Ridge.	Jerusalem.	Lewisville.	Macksburg.	Marietta.	Mingo.	New Castle.	New Matamoras.	Plum Run.	Rinards Mill.	Scio.	Steubenville.	Trail Run.	Woodsfield.	Total.
January	3	...	1	4	1	10	...	8	...	1	2	5	12	2	1	2	...	4	...	...	...	1	57
February	7	...	...	8	1	10	1	6	...	...	1	5	6	4	...	1	...	2	1	...	...	1	54
March	7	...	1	2	1	17	...	6	...	2	3	8	6	...	...	3	2	1	1	...	1	3	64
April	6	...	1	7	...	7	...	9	...	3	...	2	18	4	...	1	...	3	2	...	...	4	67
May	5	...	1	5	2	15	...	...	1	2	2	3	5	3	...	1	...	1	2	4	...	1	53
June	11	...	...	7	...	13	1	...	1	2	...	5	17	3	1	3	1	1	1	5	...	...	72
July	10	...	...	4	1	31	1	...	...	2	...	5	20	1	1	1	...	1	1	10	...	2	91
August	13	...	1	9	...	19	2	...	...	3	...	8	15	6	...	2	...	...	...	8	1	3	90
September	9	...	...	3	...	23	...	...	1	2	2	5	13	7	...	2	5	1	2	5	...	2	82
October	5	...	...	4	1	11	1	...	...	1	1	6	9	2	...	...	1	...	1	7	1	2	53
November	8	...	1	5	2	18	...	...	...	5	2	5	13	3	...	3	...	...	...	9	1	3	78
December	8	1	4	3	...	13	...	...	...	...	2	8	11	2	...	1	...	...	...	2	...	4	59
Total	92	1	10	61	9	187	6	29	3	23	15	65	145	37	3	20	9	14	11	50	4	26	a 820

a Includes 109 wells which produce gas.

Number of dry holes drilled in southeastern Ohio oil field, 1905–1909, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
905	45	40	69	62	67	61	62	63	55	40	56	42	662
906	32	51	53	46	47	68	54	67	49	57	45	61	630
907	35	26	31	34	47	51	60	51	52	53	45	36	521
908	25	33	30	32	44	50	49	45	67	55	59	82	571
909	57	54	64	67	53	72	91	90	82	53	78	59	820

nitial daily production of new wells completed in southeastern Ohio oil field in 1909, by districts and months, in barrels.

Month.	Alliance.	Barnesville.	Cadiz.	Chester Hill.	Clear Fork.	Corning.	Graysville.	Island Creek.	Jackson Ridge.	Jerusalem.	Lewisville.	Macksburg.
anuary	678	....	21	35	7	202	5	143	......	1	......	81
February	198	....	10	3	......	513	......	630	2	......	36	145
March	296	....	15	16	5	273	......	113	......	6	11	37
April	251	....	2	20	3	259	5	488	......	......	1	75
May	230	....	18	38	17	579	5	....	......	17	17	100
une	362	....	5	41	18	1,149	1	....	10	50	13	115
uly	252	....	12	30	20	564	5	....	50	5	58	37
ugust	153	....	10	42	15	1,176	......	....	4	5	42	59
eptember	141	....	......	70	......	866	......	....	4	10	15	96
ctober	121	2	......	26	15	1,089	......	....	......	8	25	342
November	192	....	8	19	20	861	......	....	......	25	210	63
December	62	....	......	23	4	582	......	....	10	......	72	80
Total	2,936	2	101	363	124	8,113	21	1,374	80	127	500	1,230

Month.	Marietta.	Mingo.	New Castle.	New Matamoras.	Plum Run.	Rinard Mills.	Scio.	Steubenville.	Trailrun.	Woodsfield.	Total.
anuary	100	300	80	14	40	......	......	....	......	347	2,054
February	83	130	7	37	......	1	7	....	......	688	2,490
March	227	200	....	30	5	10	......	....	......	495	1,739
April	535	40	....	22	......	......	3	....	......	90	1,794
May	149	50	8	122	......	......	......	1,085	......	55	2,490
une	292	....	....	70	5	5	......	1,434	3	79	3,652
uly	409	10	....	25	2	2	......	913	6	229	2,629
ugust	183	5	....	10	3	......	......	390	4	30	2,131
eptember	297	....	....	6	3	2	1	183	......	43	1,737
ctober	336	....	75	67	......	......	7	93	......	....	2,206
November	473	....	10	......	3	20	......	37	5	25	1,971
December	386	10	5	15	......	......	......	....	5	5	1,259
Total	3,470	745	185	418	61	40	18	4,135	23	2,086	26,152

Total initial daily production of new wells in southeastern Ohio oil field, 1905–1909, by months, in barrels.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.	Average.
1905	1,176	595	671	801	1,300	822	855	1,077	1,378	1,397	1,437	1,564	13,073	1,089
1906	847	1,026	1,019	751	1,102	1,022	1,226	1,982	2,179	716	692	852	13,414	1,118
1907	802	170	185	436	697	765	617	850	584	555	641	608	6,910	576
1908	675	347	172	541	798	1,050	625	1,649	2,774	2,413	2,113	1,174	14,331	1,194
1909	2,054	2,490	1,739	1,794	2,490	3,652	2,629	2,131	1,737	2,206	1,971	1,259	26,152	2,179

THE CLINTON SAND AS A SOURCE OF OIL.

In 1907 an oil field was opened near Bremen, in Fairfield County, a description of which and of other pools in this Clinton sand has been furnished by Dr. J. A. Bownocker, State geologist of Ohio.

The discovery of oil in the Clinton sand of Ohio is a direct result of the close association of gas and oil. Gas was discovered in this formation at Lancaster in 1887 and a little later at Newark and Thurston. This territory developed into one of the finest gas fields ever known.

As is well known, large bodies of gas are seldom remote from oil, and this fact has led to an extensive search for the latter fuel. The first pool of commercial proportions found in this formation was in northern Vinton County, in the southern part of the State, in 1899. The confines of the field were soon determined, the results on the whole being disappointing. In the summer of 1894, another small pool was found, the location being near the village of Bladensburg, in the southeastern corner of Knox County. This, too, was unsatisfactory. Near the close of 1905 a few oil wells were found near Butler, Richland County, in the northern part of the State. This oil was all reported to be of the "water white" variety and was used in the raw state in a small way for illuminating purposes. These pools, although of little importance, showed oil at widely separated localities and made further tests certain.

In the spring of 1907 a number of successful wells were drilled in the eastern part of Fairfield County, near the villages of Rushville and Bremen, at a depth of about 2,500 feet. These marked the opening of the Bremen field, the one important source of oil in the Clinton sand in Ohio. Since that time the drill has been busy, and from near these two villages it has moved east and southeast with important extensions of the producing territory. At the present time the principal pools are the Pleasantville and the Bremen, in eastern Fairfield County, and the Junction City, in Jackson Township, Perry County. Outside of these, small pools have been found in Coal and Reading Townships of Perry County, and occasional wells in other places, such as Crooksville, Perry County, and Falls Gore Township, Hocking County. Quite recently good wells have been secured at two or three points in the western part of Muskingum County, giving some promise of important extensions to the producing territory. A well near Crooksville found the oil sand at 3,432 feet, making it the deepest producing well in Ohio and among the deepest in the United States.

The oil is of Pennsylvania grade and is of choice quality. The production of the Bremen field has been as follows:

Production of petroleum in Bremen field, Fairfield County, Ohio, 1907–1910, in barrels.

1907 (five months)	16,698
1908	322,152
1909	799,284
1910 (eight months)	1,343,162

The rock structure of the sand in the Bremen field, in its larger aspects at least, is very simple, dipping to the east and south at an average rate of 57 feet per mile. Small rolls are occasionally found, so that reverses of dip exist. Those observed by the writer were all small, but further study might disclose larger ones. Westward the sand thins and disappears before the longitude of the middle of the State is reached, its place being taken by shales. The great reservoirs of gas are always, or nearly so, found near the western margin of the sand. The oil exists at greater depths to the east. The sand in the Bremen field is quite persistent and averages about 25 feet in thickness. It is of moderate grain and ranges from light gray to red brown in color. Some maintain that the sand is free from water; others assert that it is present in small quantity. Most likely the water that is occasionally found gets into the sand through leaks in the casing. Farther east the sand is more persistent, though the depth is greater, and probably there will be the exploration in the near future.

North from the Bremen field the sand is more spotted and thinner, and hence drilling is more hazardous. Work has extended to the shore of Lake Erie, with only an occasional oil well as a reward. Here, as farther south, the gas is found along the western border of the sand and the oil farther east. Likewise the sand appears to thicken in the latter direction.

In southern Ohio the sand has not been found farther south than the northern part of Jackson County, though wells have extended to the bank of the Ohio River. Probably the sand will be found thicker and more regular farther east. Oil in this formaation has not been found south of Vinton County.

There have been no new developments in the old Trenton limestone field of northwestern Ohio and probably no important additions will ever be made. It is said that a half dozen wells are abandoned for each new one drilled, and future reports on this territory will be that of a declining industry.

Work in southeastern Ohio has developed nothing new of importance. Some drilling has been done in every county and considerable drilling along the borders of old pools, but the returns have been small. This section of the State has been so exploited that it is difficult to think of additional large pools being found there.

LIMA-INDIANA OIL FIELD.

Inasmuch as these oils are characterized by sulphur compounds requiring special refining methods, they are grouped together.

PRODUCTION OF LIMA-INDIANA FIELD.

In the following table will be found the production of the Lima-Indiana field, by States and months, for the year 1909:

Production of petroleum in the Lima-Indiana field in 1909, by months, in barrels.

Month.	Lima, Ohio.	Indiana.	Total.
January	520,146	202,055	722,201
February	469,111	182,914	652,025
March	566,455	221,455	787,910
April	524,356	211,265	735,621
May	518,656	212,575	731,231
June	515,396	211,981	727,377
July	512,017	205,182	717,199
August	488,034	198,306	686,340
September	470,970	184,207	655,177
October	467,788	172,505	640,293
November	457,845	170,871	628,716
December	404,583	122,770	527,353
Total	5,915,357	2,296,086	8,211,443

In the following table will be found the production of the Lima-Indiana field from 1900 to 1909, inclusive, with its percentage of the total production of the United States, the increase or decrease made each year, and the percentage of increase or decrease:

Production of petroleum in the Lima-Indiana field, 1900–1909.

Year.	Production, in barrels.	Percentage of total production.	Increase.	Decrease.	Percentage.	
					Increase.	Decrease.
1900	21,758,750	34.20	1,533,394		7.58	
1901	21,933,379	31.61	174,629		.80	
1902	23,358,826	26.31	1,425,197		6.50	
1903	24,080,264	23.97	721,438		3.09	
1904	24,689,184	21.09	608,920		2.53	
1905	22,294,171	16.55		2,395,013		9.70
1906	17,554,661	13.88		4,739,510		21.26
1907	13,121,094	7.90		4,433,567		25.26
1908	10,032,305	5.62		3,088,789		23.54
1909	8,211,443	4.51		1,820,862		18.15

Production and value of petroleum in the Lima-Indiana field, 1905–1909, in barrels.

Year.	North Lima, Ohio.		South Lima, Ohio.		Indiana.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1905	6,931,635	$6,290,459	4,398,289	$3,771,533	10,964,247	$9,404,909	22,294,171	$19,466,901
1906	6,859,669	6,479,607	3,021,515	2,678,034	7,673,477	6,770,066	17,554,661	15,927,707
1907	6,399,917	6,016,238	1,593,140	1,409,242	5,128,037	4,536,930	13,121,094	11,962,410
1908	5,430,124	5,574,400	1,318,552	1,287,485	3,283,629	3,203,883	10,032,305	10,065,768
1909	4,761,065	4,434,277	1,154,292	1,017,220	2,296,086	1,997,610	8,211,443	7,449,107

PIPE-LINE RUNS AND DELIVERIES AND STOCKS IN LIMA-INDIANA OIL FIELD.

In the following tables are given the pipe-line runs, deliveries, and stocks on hand in the Lima-Indiana field in 1909:

Pipe-line runs in the Lima-Indiana oil field in 1909, by months, in barrels.

Month.	Buckeye pipe line.	Other Ohio.	Indiana pipe line.	Other Indiana.	Total.
January	353,155	166,991	176,598	25,457	722,201
February	320,336	148,775	157,713	25,201	652,025
March	385,399	181,056	192,585	28,870	787,910
April	359,121	165,235	182,744	28,521	735,621
May	356,521	162,135	184,343	28,232	731,231
June	355,369	160,027	182,105	29,876	727,377
July	348,685	163,332	174,863	30,319	717,199
August	336,136	151,898	169,080	29,226	686,340
September	319,654	151,316	154,764	29,443	655,177
October	316,253	151,535	145,031	27,474	640,293
November	311,614	146,231	143,834	27,037	628,716
December	278,867	125,716	102,265	20,505	527,353
Total	4,041,110	1,874,247	1,965,925	330,161	8,211,443

Pipe-line deliveries of petroleum in the Lima-Indiana oil field in 1909, by months, in barrels.

Month.	Buckeye pipe line.	Indiana pipe line.	Other.[a]	Total.
January	316,540	508,146	186,975	1,011,661
February	281,741	502,086	186,975	970,802
March	249,685	675,197	186,975	1,111,857
April	238,675	655,305	186,975	1,080,955
May	257,056	612,814	186,975	1,056,845
June	179,654	644,595	186,975	1,011,224
July	133,637	622,130	186,975	942,742
August	336,861	619,162	186,975	1,142,998
September	245,044	577,142	186,975	1,009,161
October	319,118	863,460	186,975	1,369,553
November	235,368	885,239	186,976	1,307,583
December	242,193	840,216	186,976	1,269,385
Total	3,035,572	8,005,492	2,243,702	13,284,766

[a] Averaged.

Gross stocks of crude petroleum in the Lima-Indiana oil field in 1909, by months, in barrels.

Month.	Buckeye pipe line.	Indiana pipe line.	Other.	Total
January	5,284,961	1,095,741		
February	5,045,054	1,187,754		
March	5,324,132	1,106,526		
April	5,690,773	1,103,952		
May	5,533,231	1,051,971		
June	5,306,246	1,020,674		
July	5,328,553	1,017,536		
August	5,631,765	1,203,202		
September	5,648,549	1,113,980		
October	5,396,310	1,092,779		
November	5,318,527	1,026,305		
December	5,211,847	1,037,022	183,539	6,432,408

PRICES OF PETROLEUM IN LIMA-INDIANA FIELD.

In the following table are given the fluctuations in prices for the various grades of Lima and Indiana oil in 1907, 1908, and 1909. The dates are those on which changes in prices were made.

Fluctuations in prices of Lima (Ohio) and Indiana petroleum in 1907, 1908, and 1909. per barrel.

1907.			1908.				1909.			
Date.	North Lima.	South Lima and Indiana.	Date.	North Lima.	South Lima and Indiana.	Princeton, Ind.	Date.	North Lima.	South Lima and Indiana.	Princeton, Ind.
January 1	$0.90	$0.85	January 1	$0.94	$0.89	$0.68	January 1	$1.04	$0.99	$0.68
February 11	.92	.87	February 13	.99	.94		May 4	.99	.94	.68
March 9	.94	.89	February 26	1.04	.99		May 11	.94	.89	.68
							June 26	.89	.84	.65
							July 16	.86	.81	.62
							October 21	.84	.79	.60

In the following table are given the average monthly prices of Lima (Ohio) and Indiana petroleum, per barrel of 42 gallons each, in the years 1907 to 1909:

Average monthly prices of Ohio and Indiana petroleum in 1907, 1908, and 1909, per barrel.

Month	1907.			1908.			1909.		
	North Lima.	South Lima and Indiana.	Princeton, Ind.	North Lima.	South Lima and Indiana.	Princeton, Ind.	North Lima.	South Lima and Indiana.	Princeton, Ind.
anuary	$0.90	$0.85	$0.64	$0.94	$0.89	$0.68	$1.04	$0.99	$0.68
ebruary	.91¼	.86¼	.65¼	.97¾	.92¾	.68	1.04	.99	.68
arch	.93½	.88½	.67½	1.04	.99	.68	1.04	.99	.68
pril	.94	.89	.68	1.04	.99	.68	1.04	.99	.68
ay	.94	.89	.68	1.04	.99	.68	.96	.91	.68
ıne	.94	.89	.68	1.04	.99	.68	.93¼	.88¼	.67½
ıly	.94	.89	.68	1.04	.99	.68	.87⅜	.82⅜	.63⅜
ugust	.94	.89	.68	1.04	.99	.68	.86	.81	.62
eptember	.94	.89	.68	1.04	.99	.68	.86	.81	.62
ctober	.94	.89	.68	1.04	.99	.68	.85¼	.80¼	.61¼
ovember	.94	.89	.68	1.04	.99	.68	.84	.79	.60
ecember	.94	.89	.68	1.04	.99	.68	.84	.79	.60
Average	.93⅜	.88⅜	.67⅞	1.02⅝	.97⅝	.68	.93⅛	.88⅛	.64⅝
Average of North Lima, South Lima, and Indiana	.90⅞			1.00⅛			.90⅝		

In the following table will be found the highest, lowest, and average prices of Lima (Ohio) oil for the last ten years:

Highest, lowest, and average prices of Lima (Ohio) petroleum, 1900–1909, per barrel.

Year.	Highest.	Lowest.	Average.	Year.	Highest.	Lowest.	Average.
1900	a $1.26	b $0.74	0.98\frac{3}{4}$	1905	a $1.01	b $0.81	0.88\frac{3}{4}$
1901	a .94	b .74	.86	1906	a .98	b .85	.91$\frac{1}{8}$
1902	a 1.15	b .80	.88$\frac{1}{4}$	1907	a .94	b .85	.90$\frac{7}{8}$
1903	a 1.38	b 1.06	1.16$\frac{1}{2}$	1908	a 1.04	b .89	1.00$\frac{1}{8}$
1904	a 1.36	b .95	1.10$\frac{7}{8}$	1909	a 1.04	b .79	.90$\frac{5}{8}$

a North Lima. b South Lima.

WELL RECORD.

In the following tables are given the well records for the Lima (Ohio) oil field from 1905 to 1909, inclusive:

Number of wells completed in the Lima (Ohio) district, 1905–1909, by counties.

County.	Completed.					Dry.					Productive.				
	1905.	1906.	1907.	1908.	1909.	1905.	1906.	1907.	1908.	1909.	1905.	1906.	1907.	1908.	1909.
Allen	160	115	34	61	79	9	10	4	1	4	151	105	30	60	75
Auglaize	51	23	8	8	15	8	6	3	.....	4	43	17	5	8	11
Darke	6	.....	.....	.....	.....	4	.....	.....	.....	.....	2	.....	.....	.....	.....
Hancock	142	161	121	92	111	14	17	20	9	5	128	144	101	83	106
Henry	.....	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
Lucas	59	59	40	34	21	5	6	3	4	.....	54	53	37	30	21
Marion	1	.....	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....
Mercer	100	74	21	8	6	7	5	2	1	1	93	69	19	7	5
Ottawa	80	100	57	44	57	7	19	4	2	4	73	81	53	42	53
Paulding	2	.....	.....	.....	.....	1	.....	.....	.....	.....	1	.....	.....	.....	.....
Sandusky	279	290	212	162	116	11	13	24	12	9	268	277	188	150	107
Seneca	83	93	41	81	83	13	6	6	21	12	70	87	35	60	71
Van Wert	74	67	42	108	83	12	11	11	4	8	62	56	31	104	75
Wood	470	471	258	229	282	47	36	28	17	29	423	435	230	212	253
Wyandot	70	61	60	19	9	11	8	22	7	.....	59	53	38	12	9
Miscellaneous	1	35	12	2	a 9	1	25	9	2	a 9	.....	10	3	.....	.....
Total	1,578	1,549	906	848	872	151	162	136	80	85	1,427	1,387	770	768	787

a Includes 8 gas wells.

Number of wells completed in the Lima (Ohio) district, 1905–1909, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1905	180	107	94	139	126	122	125	109	111	142	172	151	1,578
1906	137	140	131	143	147	162	132	153	135	113	81	75	1,549
1907	69	44	86	84	76	84	92	82	81	71	75	62	906
1908	60	26	46	49	62	66	88	88	98	95	84	86	848
1909	98	59	78	86	70	92	72	78	71	64	63	41	872

Number of dry holes drilled in the Lima (Ohio) district, 1905–1909, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1905	14	6	8	12	18	10	17	10	4	15	24	13	151
1906	18	16	15	20	12	13	17	15	10	8	10	8	162
1907	14	6	13	26	8	10	10	7	8	13	8	13	136
1908	8	2	9	6	6	7	9	3	10	6	5	9	80
1909	9	4	11	6	6	7	4	7	5	6	14	6	85

Total and average initial daily production of new wells in the Lima (Ohio) district, 1905–1909, by counties, in barrels.

County.	Total initial production.					Average initial production per well.				
	1905.	1906.	1907.	1908.	1909.	1905.	1906.	1907.	1908.	1909.
Allen	2,239	1,098	284	694	708	14.8	10.5	9.5	11.6	9.4
Auglaize	448	85	22	75	138	10.4	5.0	4.4	9.4	12.5
Darke	7					3.5				
Hancock	1,730	1,687	1,090	1,042	1,253	13.5	11.7	10.8	12.6	11.8
Henry					5					5.0
Lucas	862	567	433	327	203	16.0	10.7	11.7	10.9	9.7
Mercer	1,237	1,026	220	55	35	13.3	14.9	11.6	7.9	7.0
Ottawa	678	663	479	336	450	9.3	8.2	9.0	8.0	8.5
Paulding	10					10.0				
Sandusky	2,001	1,672	1,061	822	561	7.5	6.0	5.6	5.5	5.2
Seneca	456	410	664	800	582	6.5	4.7	19.0	13.3	8.2
Van Wert	692	746	361	1,268	639	11.2	13.3	11.6	12.2	8.5
Wood	4,582	4,621	2,128	3,067	3,423	10.8	10.6	9.2	14.5	13.5
Wyandot	787	1,758	1,087	235	121	13.3	33.2	28.6	19.6	13.4
Miscellaneous		158	23				15.8	7.7		
Total	15,729	14,491	7,852	8,721	8,118	11.0	10.4	10.2	11.4	10.3

Total initial daily production of new wells in the Lima (Ohio) district, 1905–1909, by months, in barrels.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1905	1,789	950	753	964	1,199	1,545	1,141	1,048	1,564	1,688	1,620	1,468	15,729
1906	1,241	1,160	1,132	1,068	1,421	1,625	1,198	1,636	1,018	1,165	764	1,063	14,491
1907	460	523	849	699	687	593	698	575	653	1,012	527	576	7,852
1908	886	267	338	499	452	464	680	862	944	1,443	990	896	8,721
1909	1,067	767	567	678	480	900	606	853	626	718	513	343	8,118

INDIANA.

PRODUCTION.

In the following table are shown the output and value of petroleum produced in the State of Indiana during the years 1900–1909:

Production and value of petroleum in Indiana, 1900–1909, in barrels.

Year.	Quantity.	Value.	Price per barrel.
1900	4,874,392	$4,693,983	$0.96
1901	5,757,086	4,822,826	.84
1902	7,480,896	6,526,622	.87
1903	9,186,411	10,474,127	1.14
1904	11,339,124	12,235,674	1.08
1905	10,964,247	9,404,909	.86
1906	7,673,477	6,770,066	.88
1907	5,128,037	4,536,930	.88
1908	3,283,629	3,203,883	.98
1909	2,296,086	1,997,610	.87

Production of petroleum in Indiana, 1905–1909, by months, in barrels.

Month.	1905.	1906.	1907.	1908.	1909.
January	1,043,535	742,478	483,994	323,620	202,055
February	808,790	638,211	451,111	262,189	182,914
March	1,043,950	675,066	458,119	296,478	221,455
April	970,045	666,213	468,057	302,416	211,265
May	1,018,260	684,618	481,895	302,290	212,575
June	1,017,220	664,031	438,428	292,156	211,981
July	944,433	654,349	461,912	289,040	205,182
August	924,048	683,458	427,877	269,667	198,306
September	847,671	572,489	380,269	259,162	184,207
October	799,478	616,556	386,568	241,468	172,505
November	771,757	555,639	349,238	219,348	170,871
December	775,060	520,369	340,569	225,795	122,770
Total	10,964,247	7,673,477	5,128,037	3,283,629	2,296,086

WELL RECORD.

In the following tables are given the well records for Indiana from 1905 to 1909, inclusive:

Number of wells completed in Indiana, 1905–1909, by counties.

County.	Completed.					Dry.					Productive.				
	1905.	1906.	1907.	1908.	1909.	1905.	1906.	1907.	1908.	1909.	1905.	1906.	1907.	1908.	1909.
Adams	94	48	32	15	14	11	4	3	2	3	83	44	29	13	11
Blackford	65	64	22	40	23	10	9	3	9	4	55	55	19	31	19
Cass	....	....	....	....	3	....	....	....	....	2	....	....	....	....	1
Daviess	....	....	....	....	1	....	....	....	....	....	....	....	....	....	1
Delaware	653	180	65	29	13	83	39	16	14	5	570	141	49	15	8
Gibson	32	48	21	10	8	1	8	4	3	6	31	40	17	7	2
Grant	403	236	115	90	37	34	20	12	7	2	369	216	103	83	35
Hamilton	3	....	....	....	....	....	....	....	....	....	3	....	....	....	....
Henry	3	....	....	....	....	3	....	....	....	....	....	....	....	....	....
Huntington	161	123	48	17	15	2	2	2	2	3	159	121	46	15	12
Jay	204	205	152	107	63	33	27	30	25	17	171	178	122	82	46
Madison	55	3	5	2	1	25	1	2	....	....	30	2	3	2	1
Miami	7	....	....	....	1	1	....	....	....	1	6	....	....	....	....
Pike	....	....	....	....	65	....	....	....	....	27	....	....	....	....	38
Pulaski	....	....	....	....	4	....	....	....	....	3	....	....	....	....	1
Randolph	80	26	3	5	5	34	8	1	1	1	46	18	2	4	4
Vigo	....	....	....	....	2	....	....	....	....	1	....	....	....	....	1
Wabash	1	....	....	....	....	....	....	....	....	....	1	....	....	....	....
Wells	158	235	122	70	39	4	11	2	4	....	154	224	120	66	39
Miscellaneous	3	26	73	17	11	3	11	53	15	11	....	15	20	2	....
Total	1,922	1,194	658	402	305	244	140	128	82	86	1,678	1,054	530	320	219

Number of wells completed in Indiana, 1905–1909, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1905	195	133	150	187	200	160	164	149	131	111	168	174	1,922
1906	137	96	89	71	115	148	126	108	99	75	71	59	1,194
1907	50	42	69	50	57	77	61	59	45	58	47	43	658
1908	35	23	31	21	29	35	35	39	47	38	33	36	402
1909	30	16	18	24	26	36	27	27	19	29	16	37	305

Number of dry holes drilled in Indiana, 1905–1909, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1905	15	16	13	25	38	19	24	21	15	15	20	23	244
1906	10	12	8	5	15	18	11	10	13	18	17	3	140
1907	7	12	14	12	12	16	10	13	6	9	7	10	128
1908	12	9	7	5	7	7	7	7	1	6	5	9	82
1909	9	7	2	4	7	9	8	6	6	13	5	10	86

Total and average initial daily production of new wells in Indiana, 1905–1909, by counties, in barrels.

County.	Total initial production.					Average initial production per well.				
	1905.	1906.	1907.	1908.	1909.	1905.	1906.	1907.	1908.	1909.
Adams	791	441	171	177	58	9.5	10.0	5.9	13.6	5.3
Blackford	404	695	140	264	140	7.3	12.6	7.4	8.5	7.4
Cass					2					2.0
Daviess					20					20.0
Delaware	18,608	4,774	715	312	142	32.6	33.8	14.6	20.8	17.8
Gibson	324	795	304	75	35	10.5	19.9	17.9	10.7	17.5
Grant	3,949	1,742	770	749	167	10.7	8.1	7.5	9.0	4.8
Hamilton	45					15.0				
Huntington	3,079	1,650	485	154	77	19.4	13.6	10.5	10.3	6.4
Jay	2,713	2,742	1,362	900	378	15.9	15.4	11.2	11.0	8.2
Madison	471	30	50	15	40	15.7	15.0	16.7	7.5	40.0
Miami	50					8.3				
Pike					2,385					62.7
Pulaski					5					5.0
Randolph	1,693	608	25	35	130	36.8	33.8	12.5	8.8	32.5
Vigo					20					20.0
Wabash	6					6.0				
Wells	1,754	2,109	1,067	537	264	11.4	9.4	8.9	8.1	6.8
Miscellaneous		253	308	40			16.9	15.4	20.0	
Total	33,887	15,839	5,397	3,258	3,863	20.2	15.0	10.2	10.2	17.6

Total initial daily production of new wells in Indiana, 1905–1909, by months, in barrels.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1905	4,736	2,111	2,746	3,344	3,016	3,467	2,395	2,213	2,361	2,689	2,536	2,273	33,887
1906	1,836	1,192	1,019	992	1,602	2,168	2,373	1,637	1,049	666	737	568	15,839
1907	438	256	566	380	625	655	427	454	313	513	418	352	5,397
1908	258	135	225	144	262	335	201	322	563	301	241	271	3,258
1909	308	59	200	241	281	298	467	287	381	445	114	782	3,863

ILLINOIS OIL FIELD.

PRODUCTION.

The total output from the Illinois field declined from 33,686,238 barrels in 1908 to 30,898,339 barrels in 1909. This was by no means so great a decrease as had been forecast, and this very large total is testimony to the staying quality of the field, which has been aided materially by extensions described on a subsequent page by Mr. Raymond S. Blatchley, of the State geological survey.

The total production, by months, for the last five years is given in the following table:

Production of petroleum in Illinois, 1905–1909, by months, in barrels.

Month.	1905.	1906.	1907.	1908.	1909.
January		55,680	781,812	2,703,973	2,668,607
February		65,208	956,399	2,572,115	2,510,548
March		19,352	1,547,323	2,825,491	2,757,794
April		102,862	1,874,465	3,249,690	2,562,215
May		267,746	2,138,918	3,223,515	2,829,277
June	6,521	410,655	1,879,362	3,081,848	2,670,549
July	17,306	610,401	2,422,192	2,693,288	2,728,857
August	23,827	778,464	2,446,042	2,808,667	2,719,958
September	26,586	722,168	2,605,663	2,675,385	1,902,197
October	27,589	463,819	2,863,812	2,709,913	2,560,072
November	34,611	350,985	2,510,146	2,479,926	2,497,847
December	44,644	549,710	2,255,839	2,662,427	2,490,418
Total	181,084	4,397,050	24,281,973	33,686,238	30,898,339

Production and value of petroleum in Illinois, 1905–1909, in barrels.

Year.	Ohio Oil Co.	Other lines.	Total quantity.	Total value.
1905	156,503	24,581	181,084	$116,561
1906	4,385,471	11,579	4,397,050	3,274,818
1907	23,733,790	548,183	24,281,973	16,432,947
1908	31,972,634	1,713,604	33,686,238	22,649,561
1909	27,640,773	3,257,566	30,898,339	19,788,864

PIPE-LINE RUNS AND DELIVERIES AND STOCKS.

The following tables show the runs of the Ohio Oil Company during the years 1905–1909, and deliveries and stocks in 1907, 1908, and 1909, by months:

Pipe-line runs of the Ohio Oil Co. in Illinois, 1905–1909, by months, in barrels.

Month.	Pipe-line runs.				
	1905.	1906.	1907.	1908.	1909.
January		55,680	752,671	2,497,359	2,494,492
February		65,208	918,620	2,464,914	2,358,198
March		19,352	1,494,598	2,591,911	2,568,392
April		102,862	1,823,025	3,089,417	2,388,309
May		267,746	2,094,195	3,084,816	2,536,413
June	5,489	410,655	1,830,634	2,965,786	2,365,956
July	9,208	610,401	2,376,281	2,579,977	2,413,218
August	15,092	778,464	2,398,895	2,690,931	2,411,483
September	19,592	722,168	2,560,593	2,555,871	1,595,934
October	26,444	463,819	2,818,032	2,582,561	2,228,269
November	34,766	350,985	2,464,981	2,356,386	2,149,372
December	45,912	538,131	2,201,265	2,512,705	2,130,737
Total	156,503	4,385,471	23,733,790	31,972,634	27,640,773

Deliveries and stocks in 1907–1909, by months, in barrels.

Month.	Deliveries.			Stocks.		
	1907.	1908.	1909.	1907.	1908.	1909.
January	142,001	1,720,631	324,887	2,509,598	14,129,954	25,876,529
February	401,344	1,882,978	869,212	3,040,111	15,069,278	26,203,238
March	444,078	1,010,459	721,519	4,117,635	15,975,633	26,630,509
April	385,432	1,476,192	891,423	5,528,759	17,420,534	26,856,675
May	563,585	1,869,461	903,838	7,117,033	19,077,020	27,593,494
June	551,502	1,846,947	1,077,383	8,448,344	20,456,387	27,899,220
July	1,395,238	2,012,288	1,176,410	9,387,999	21,036,143	27,627,086
August	1,440,640	1,774,354	1,052,431	10,355,000	22,267,197	27,683,334
September	1,105,589	1,488,283	849,533	12,557,522	23,485,690	28,399,427
October	1,590,566	1,394,983	938,860	13,724,691	24,396,787	28,535,636
November	1,815,964	1,284,304	1,120,751	14,275,036	24,905,168	28,373,985
December	848,450	1,789,158	685,585	15,751,305	25,252,468	28,671,543
Total	10,684,389	19,550,038	10,611,832	....	....	....

PRICES.

In the following table are given the dates of change and the changes in prices at wells of the different grades of petroleum produced in Illinois during the years 1908 and 1909:

Fluctuation in prices, per barrel, of Illinois petroleum in 1908 and 1909.

1908.			1909.		
Date.	Above 30° B.	Below 30° B.	Date.	Above 30° B.	Below 30° B.
January 1	$0.68	$0.60	January 1	$0.68	$0.60
			June 26	.65	.57
			July 16	.62	.54
			October 21	.60	.52

In the following table are given the average monthly prices paid for Illinois petroleum at wells in Illinois from 1905 to 1909, inclusive:

Average monthly prices of Illinois petroleum, 1905–1909, per barrel.

Month.	1905.	1906.	1907.	1908.		1909.	
				Above 30° B.	Below 30° B.	Above 30° B.	Below 30° B.
January	....	$0.79	$0.64	$0.68	$0.60	$0.68	$0.60
February	....	.79	.65¼	.68	.60	.68	.60
March	....	.79	.67½	.68	.60	.68	.60
April	....	.80⅝	.68	.68	.60	.68	.60
May	....	.83	.68	.68	.60	.68	.60
June	$0.60	.83	.68	.68	.60	.67½	.59½
July	.60	.82¾	.68	.68	.60	.63⅜	.55⅝
August	.60	.71⅞	.68	.68	.60	.62	.54
September	.61	.64	.68	.68	.60	.62	.54
October	.64	.64	.68	.68	.60	.61¼	.53¼
November	.66	.64	.68	.68	.60	.60	.52
December	.70	.64	.68	.68	.60	.60	.52
Average	.644	.745	.67⅜	.68	.60	.64⅝	.56⅝

WELL RECORD.

In the following tables are given the well records for Illinois from 1906 to 1909, inclusive:

Number of wells completed in Illinois, 1906–1909, by counties.

County.	Completed.				Dry.				Productive.			
	1906.	1907.	1908.	1909.	1906.	1907.	1908.	1909.	1906.	1907.	1908.	1909.
Clark	1,337	1,176	385	181	164	201	87	47	1,173	975	298	134
Coles	65	56	9	12	14	11	1	3	51	45	8	9
Crawford	1,060	2,840	2,322	2,093	164	376	336	355	896	2,464	1,986	1,738
Cumberland	558	152	42	33	53	13	11	10	505	139	31	23
Edgar	37	25	9	6	16	14	2	4	21	11	7	2
Jackson	......	......	......	3	......	......	......	2	......	......	......	1
Jasper	......	......	......	18	......	......	......	11	......	......	......	7
Lawrence	176	691	762	724	33	70	78	56	143	621	684	668
Macoupin	......	......	......	9	......	......	......	8	......	......	......	1
Madison	......	......	......	2	......	......	......	1	......	......	......	1
Marion	......	......	......	23	......	......	......	17	......	......	......	6
Randolph	......	......	......	12	......	......	......	10	......	......	......	2
Saline	......	......	......	2	......	......	......	1	......	......	......	1
Miscellaneous	50	48	45	33	46	43	40	33	4	5	5	......
Total	3,283	4,988	3,574	3,151	490	728	555	558	2,793	4,260	3,019	2,593

Number of wells completed in Illinois, 1906–1909, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1906	......	......	......	108	253	359	435	496	449	453	376	354	3,283
1907	253	356	351	387	493	639	521	461	400	363	430	334	4,988
1908	303	157	187	197	264	390	474	417	344	290	273	278	3,574
1909	213	224	216	263	321	342	346	303	282	242	223	176	3,151

Number of dry holes drilled in Illinois, 1906–1909, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1906	......	......	......	20	37	41	69	82	69	47	64	61	490
1907	41	55	60	40	64	75	72	45	62	82	80	52	728
1908	55	22	37	33	35	54	65	55	49	51	47	52	555
1909	41	47	45	38	45	53	50	57	50	48	52	32	558

Total and average initial daily production of new wells in Illinois, 1906–1909, by counties, in barrels.

County.	Total initial production.				Average initial production per well.			
	1906.	1907.	1908.	1909.	1906.	1907.	1908.	1909.
Clark	31,060	20,385	6,953	3,219	26.5	20.9	23.3	24.0
Coles	279	314	122	95	5.5	7.0	15.3	10.6
Crawford	59,204	84,163	46,694	44,379	66.1	34.2	23.5	25.5
Cumberland	15,115	3,612	303	558	29.9	26.0	9.8	24.3
Edgar	101	118	45	10	4.8	10.7	6.4	5.0
Jackson	......	......	......	3	......	......	......	3.0
Jasper	......	......	......	50	......	......	......	7.1
Lawrence	7,230	30,543	24,793	41,056	50.6	49.2	36.2	61.5
Macoupin	......	......	......	5	......	......	......	5.0
Madison	......	......	......	10	......	......	......	10.0
Marion	......	......	......	223	......	......	......	37.2
Randolph	......	......	......	145	......	......	......	72.5
Saline	......	......	......	3	......	......	......	3.0
Miscellaneous	23	28	50	......	5.8	5.6	10.0	......
Total	113,012	139,163	78,960	89,756	40.5	32.7	26.2	34.6

Total initial daily production of new wells in Illinois, 1906–1909, by months, in barrels.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1906....	....	....	....	3,736	8,137	17,148	15,262	22,432	9,705	14,039	10,611	11,942	113,012
1907....	9,433	9,842	10,392	11,083	13,329	18,807	17,375	11,240	10,967	8,157	9,780	8,758	139,163
1908....	6,144	3,329	4,133	4,285	6,628	9,856	9,475	8,322	7,848	6,091	6,242	6,607	78,960
1909....	5,060	4,833	5,018	5,237	7,681	9,050	9,820	8,661	8,324	8,904	9,628	7,540	89,756

The following table shows the quantity of petroleum shipped by railroad from the Illinois oil field, 1906 to 1909, by months:

Shipments of petroleum by railroad in tank cars from Illinois oil field, in pounds and equivalent in barrels, 1906–1909, by months.

Month.	1906.[a]		1907.[b]		1908.[c]		1909.[d]	
	Pounds.	Barrels.	Pounds.	Barrels.	Pounds.	Barrels.	Pounds.	Barrels.
January.....	18,083,407	60,134	2,607,940	8,701	27,369,575	91,807	42,962,321	144,511
February ...	15,444,464	51,358	4,361,996	14,598	21,191,859	71,170	33,135,044	111,407
March......	4,814,239	16,009	7,158,170	23,947	39,352,395	132,300	45,220,034	152,056
April.......	10,687,154	35,539	12,609,699	42,249	35,198,236	118,074	32,756,603	109,872
May........	48,151,478	160,121	47,076,459	158,227	25,177,339	84,290	46,914,958	157,783
June........	107,669,378	358,039	49,701,853	166,644	36,566,990	122,317	54,585,149	183,432
July........	155,158,474	515,956	96,137,954	322,622	32,087,310	107,688	47,158,942	158,642
August......	160,831,482	534,821	66,661,072	223,134	20,912,433	70,171	49,602,064	166,943
September..	110,852,921	368,625	21,203,105	70,555	24,771,903	83,042	51,574,673	173,509
October.....	48,881,173	162,547	17,055,726	56,570	30,427,564	102,163	59,425,540	200,067
November ..	14,659,266	48,747	16,831,726	56,080	41,096,712	138,147	58,881,214	198,044
December...	9,275,053	30,843	19,952,993	66,692	37,751,352	126,967	55,130,392	185,166
	704,508,489	2,342,739	361,358,693	[e]1,210,019	371,903,668	[e]1,248,136	577,346,934	[e]1,941,432

[a] Calculations made on the basis of 7.16 pounds to the gallon. Shipments were made from Bridgeport, Oilfield, and Stoy. The railroads which shipped crude petroleum from Illinois were the Vandalia, the Baltimore & Ohio, the Cincinnati, Hamilton & Dayton, and the Indianapolis Southern.

[b] Shipments were made from Duncansville, Lawrenceville, Stoy, Robinson, Bridgeport, Oilfield, and Casey. The railroads which shipped crude petroleum from Illinois were the Vandalia, the Baltimore & Ohio, the Cincinnati, Hamilton & Dayton, the Indianapolis Southern, and the Cleveland, Cincinnati, Chicago & St. Louis.

[c] Shipments were made from Duncansville, Lawrenceville, Stoy, Robinson, Bridgeport, Sparta, and Casey. The railroads which shipped crude petroleum from Illinois were the Vandalia, the Baltimore & Ohio, the Illinois Southern, the Indianapolis Southern, and the Cleveland, Cincinnati, Chicago & St. Louis.

[d] Shipments were made from Duncansville, Flat Rock, Lawrenceville, Stoy, Robinson, Bridgeport, Casey, and Sparta, the same railroads shipping in 1909 as in 1908. The number of tank cars shipped in 1909 was 11,820.

[e] Calculations made according to specific gravity of the oil, ranging from 296.476 to 321.17 pounds to the barrel.

ILLINOIS OIL FIELD IN 1909.

The following statement of the conditions in the Illinois oil field in 1909 has been furnished by Mr. Raymond S. Blatchley, of the Illinois Geological Survey:

Developments in 1909.—The largest development in 1909, from the viewpoint of new drilling, took place in Crawford County, and the most profitable development was in Lawrence County. Clark, Coles, Cumberland, and Edgar counties showed continued decrease from the years 1907 and 1908, and, in fact, a reversal of development began in the abandonment of portions of the field. The shallow sands of these counties have gradually lost their production until they are almost inactive in the original wells. The original production of Crawford County has dwindled greatly, and the standing of the county has only been kept up through the discovery of extensions at Oblong, New Hebron, and Flat Rock.

The activity of new development shifted southward from Clark and Crawford to Lawrence County, where six distinct oil sands are attracting attention. These are found at depths varying from 800 to 1,900 feet, and in descending order they are the Bridgeport No. 1 and No. 2, the Buchanan, the Kirkwood, the Tracy, and the

McClosky sands. The three sands last mentioned have developed into the richest in the field. They are found at the average depths of 1,450, 1,700, and 1,750 feet, respectively, and have shown remarkable initial production and constancy. These deep sands have not been tapped extensively because of an inactive market, and especially of the increased expense from caving conditions of the lower formations.

There was an increase in "wildcatting" during the year, especially along the western edge of the great structural basin of southern and central Illinois. The drilling in Greene, Jersey, Macoupin, Madison, and St. Clair counties was scattered and had meager results. A new gas field of fair production was opened up near Carlinville; the supply is sufficient to provide for the town. A small showing of oil was found at Waverly, in Morgan County, and at Eldorado, in Saline County. Neither well produced oil in commercial quantity. An important well was drilled about 2 miles southeast of Duquoin with a view of testing a structural terrace which exists there and upon which the conditions are favorable to the accumulation of oil. The bore apparently passed through the oil-bearing sands of the Chester formations, but the hole was barren of oil. It was proved that the well lay down the side of the terrace and was not advantageously located.

During the year a new field was opened near Sandoval, in Marion County. Several wells yielded oil and gas in abundant quantity. The oil is of about 32° B. gravity and the gas of about 350 pounds pressure. The field received its impetus from the finding of oil in a coal mine near Centralia in 1907. Drilling was started, with the result that oil was first found near the mine immediately under the workable coal and later at Sandoval, about 8 miles away, at much lower horizons that correspond to the Chester formations of the Mississippian rocks. Two pay sands were found that seem to correlate with the Kirkwood sand of the Lawrence County field. The field seems to lie along an irregular terrace that is perhaps a northward extension of the Duquoin terrace.

Scientific field investigation of the Illinois Geological Survey in 1910.—The Illinois Geological Survey is taking up the investigation of minor deformations within the Illinois basin with a view of attracting drilling to those localities where the conditions are suggestive of the accumulation of oil. A great deal of drilling has been done without regard to the structure of the basin, and consequently many barren wells have been put down. The work consists of tracing the No. 6 coal along several cross sections of the State and using it as a key horizon. The presence of promising disturbances in the coal is suggestive of similar structure in the lower parallel formations.

An investigation is also being made of the eastern Illinois oil fields with respect to the stratigraphy and structure of the oil sands of the southern portion. The work is being based upon the correlation of about 5,000 well records and upon individual contour maps of each sand. The studies of gas, oil, and water occurrences are being made with respect to their relation to the contours. The quantities of oil are studied in detail to see if they bear any particular relation to the minor undulations upon the La Salle anticline. Sand thicknesses are to be investigated to see if they bear any direct relation to the production of oil and to any irregularities of contour. Other minor problems are to be pursued which materially affect the production of oil and gas. Drill samples from various parts of the fields are to be studied and the geological interpretations are to be made, establishing the identity of beds that are uncertain at the present time. Particular attention is to be paid to the No. 6 coal, and an effort will be made to trace it throughout the eastern portion of the State.

MID-CONTINENT FIELD.

In Oklahoma strenuous efforts were made by the Producers' Association to suspend drilling operations and thus check the increasing production. The rate of production was successfully affected, although the increase was not entirely stopped, the total product being 47,859,208 barrels in 1909 against 45,798,765 barrels in 1908.

Transportation facilities improved during the year. The assurance of a pipe line to Baton Rouge in Louisiana gave the operators confidence in their ability to dispose of the product upon favorable terms and put new life into the field. In September an exceptionally large gusher was developed 5 miles north of Okmulgee. The success of this well led to the development of the Preston pool, with the usual period of active speculation in leases. Drilling was greatly hindered by the extreme drought.

Kansas continued to decline in its production, both of petroleum and of natural gas. The output of petroleum amounted to 1,263,764 barrels in 1909, as compared with 1,801,781 barrels in 1908.

PRODUCTION.

In the following table is shown the production and increase and decrease, with percentages, of petroleum in the Mid-Continent field since 1889:

Production and increase and decrease, with percentages, of petroleum in the Mid-Continent oil field, 1889–1909, by States, in barrels.

Year.	Kansas.	Oklahoma.	Northern Texas.[a]	Total.	Per cent of total production.	Increase.	Per cent increase.
1899	500			500			
1890	1,200			1,200		700	140.00
1891	1,400	30		1,430		230	19.17
1892	5,000	80		5,080		3,650	255.24
1893	18,000	10		18,010	0.04	12,930	254.53
1894	40,000	130		40,130	0.08	22,120	122.82
1895	44,430	37		44,467	0.08	4,337	10.81
1896	113,571	170	1,400	115,141	0.19	70,674	158.93
1897	81,098	625	65,925	147,648	0.24	32,507	28.23
1898	71,980		544,620	616,600	1.11	468,952	317.62
1899	69,700		668,483	738,183	1.29	121,583	19.72
1900	74,714	6,472	[b]836,039	917,225	1.44	179,042	24.25
1901	179,151	10,000	[b]800,545	989,696	1.43	72,471	7.90
1902	331,749	37,100	617,871	986,720	1.12	[c]2,976	[c].30
1903	932,214	138,911	501,960	1,573,085	1.57	586,365	59.42
1904	4,250,779	1,366,748	569,102	6,186,629	5.28	4,613,544	293.28
1905	[d]12,013,495	([e])	520,282	12,533,777	9.30	6,347,148	102.60
1906	[d]21,718,648	([e])	1,117,905	22,836,553	18.05	10,302,776	82.20
1907	2,409,521	43,524,128	912,618	46,846,267	28.20	24,009,714	105.14
1908	1,801,781	45,798,765	723,264	48,323,810	27.07	1,477,543	3.15
1909	1,263,764	47,859,218	681,940	49,804,922	27.34	1,481,112	3.06

[a] Includes counties of Navarro, Jack, and McLennan.
[b] Includes a small production in southern Texas.
[c] Decrease.
[d] Includes the production of Oklahoma.
[e] Included in the production of Kansas.

Production and value of petroleum in the Mid-Continent field, 1905–1909, by States, in barrels.

Year.	Kansas and Oklahoma.		Northern Texas.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1905	12,013,495	$6,546,398	520,282	$361,604	12,533,777	$6,908,002
1906	21,718,648	9,615,198	1,117,905	740,542	22,836,553	10,355,740
1907	45,933,649	18,478,658	912,618	721,577	46,846,267	19,200,235
1908	47,600,546	18,441,538	723,264	479,072	48,323,810	18,920,610
1909	49,122,982	17,920,623	681,940	393,732	49,804,922	18,314,355

Production of petroleum in the Mid-Continent field in 1908 and 1909, by months, in barrels.

Month.	1908.				1909.			
	Kansas.	Oklahoma.	Northern Texas.	Total.	Kansas.	Oklahoma.	Northern Texas.	Total.
January	177,794	3,953,052	74,374	4,205,220	109,287	3,844,553	55,723	4,009,563
February	162,323	3,805,151	76,391	4,043,865	109,436	3,436,876	48,400	3,594,712
March	175,028	4,172,727	61,731	4,409,486	120,191	3,972,776	54,432	4,147,399
April	161,628	4,040,588	59,656	4,261,872	116,120	3,684,679	52,325	3,853,124
May	153,667	3,516,343	58,230	3,728,240	110,824	4,014,454	50,860	4,176,138
June	154,379	3,031,074	60,464	3,245,917	108,843	4,364,423	52,909	4,526,175
July	146,004	4,058,234	56,875	4,261,113	103,771	4,020,178	55,947	4,179,896
August	144,947	3,931,030	58,493	4,134,470	105,214	4,112,421	56,856	4,274,491
September	136,170	3,707,147	58,642	3,901,959	100,472	4,231,574	58,448	4,390,494
October	134,008	3,946,122	53,115	4,133,245	97,886	4,023,977	59,667	4,181,530
November	126,245	3,705,268	52,313	3,883,826	96,403	4,132,394	75,578	4,304,375
December	129,588	3,932,029	52,980	4,114,597	85,317	4,020,913	60,795	4,167,025
Total	1,801,781	45,798,765	723,264	48,323,810	1,263,764	47,859,218	681,940	49,804,922

PRODUCTION IN KANSAS AND OKLAHOMA.

Production of petroleum in Kansas and Oklahoma in 1908 and 1909, by months, in barrels.

Month.	1908.			1909.			
				Runs from wells.			
	Pipe-line runs.	Shipments of crude by rail and consumption by refineries and fuel users.	Total.	Gulf, Prairie, and Texas companies, pipe lines.	Chelsea, Cherokee, Muskogee, Nowata, and other lines to refineries.	Shipped by rail and fuel consumption not included in pipe-line runs.	Total.
January	3,903,357	227,489	4,130,846	3,564,267	181,568	208,005	3,953,840
February	3,741,224	226,250	3,967,474	3,267,782	179,827	98,703	3,546,312
March	4,102,989	244,766	4,347,755	3,789,545	184,520	118,902	4,092,967
April	3,951,697	250,519	4,202,216	3,439,825	192,892	168,082	3,800,799
May	3,328,552	341,458	3,670,010	3,695,785	189,186	240,307	4,125,278
June	2,870,823	314,630	3,185,453	4,032,636	190,195	250,435	4,473,266
July	3,847,671	356,567	4,204,238	3,680,984	188,024	254,941	4,123,949
August	3,709,025	366,952	4,075,977	3,826,469	196,748	194,418	4,217,635
September	3,542,924	300,393	3,843,317	3,936,080	206,140	189,826	4,332,046
October	3,773,919	306,211	4,080,130	3,755,164	216,111	150,588	4,121,863
November	3,565,177	266,336	3,831,513	3,796,698	229,826	202,273	4,228,797
December	3,786,836	274,781	4,061,617	3,686,631	225,906	193,693	4,106,230
Total	44,124,194	[a] 3,476,352	47,600,546	44,471,866	[b] 2,380,943	2,270,173	49,122,982
Total in 1907	44,650,341	[a] 1,288,308	45,933,649	....	....	....	....

[a] Quantity run to refineries, averaged.

[b] Quantity run by other lines, averaged.

PRICES.

In the following tables are given the prices paid by the Prairie Oil and Gas Company for petroleum of different grades in Kansas and Oklahoma during 1907, 1908, and 1909, also the average monthly price during these years:

Range of prices paid for petroleum by the Prairie Oil and Gas Company in Kansas and Oklahoma in 1907, 1908, and 1909, per barrel.

Date.	32 B. and above.	31½° to 32° B.	31° to 31½° B.	30½° to 31° B.	30° to 30½° B.	Heavy.	Date.	Above 30° B.	Below 30° B.
1907.							1909.		
Jan. 1	$0.39	$0.36	$0.33	$0.30	$0.27	$0.26	Jan. 1	$0.41	$0.28
Feb. 11	.40	.37	.34	.31	.28	.27	June 30	.38	.28
Mar. 9	.41	.38	.35	.32	.29	.28	July 22	.35	.28
1908.									
Jan. 1	.41	.38	.35	.32	.29	.28			

Average monthly price of Kansas and Oklahoma petroleum, per barrel of 42 gallons, 1907–1909, by months.

Month.	1907.		1908.				1909.	
	32° B. and above.	Heavy.	Kansas.		Oklahoma.		Above 30° B.	Below 30° B.
			Light.	Heavy.	Light.	Heavy.		
January	$0.39	$0.26	$0.41	$0.308	$0.41	$0.325	$0.41	$0.28
February	.39⅝	.26⅝	.41	.306	.41	.324	.41	.28
March	.40¾	.27¾	.41	.297	.41	.326	.41	.28
April	.41	.28	.41	.302	.41	.321	.41	.28
May	.41	.28	.41	.308	.41	.320	.41	.28
June	.41	.28	.41	.297	.41	.320	.41	.28
July	.41	.28	.41	.307	.41	.317	.37	.28
August	.41	.28	.41	.312	.41	.322	.35	.28
September	.41	.28	.41	.300	.41	.322	.35	.28
October	.41	.28	.41	.310	.41	.326	.35	.28
November	.41	.28	.41	.303	.41	.326	.35	.28
December	.41	.28	.41	.302	.41	.312	.35	.28
Average	.40¾	.27¾	.41	.304	.41	.322	.38⅛	.28

KANSAS.

Production.—The following table gives the production and sales of petroleum in Kansas in 1907, 1908, and 1909:

Production of petroleum in Kansas in 1907, 1908, and 1909, in barrels.

	1907.	1908.	1909.
Quantity piped from wells in Kansas to refineries	449,211	492,966	466,298
Rail shipments in Kansas	263,881	149,056	52,261
Estimated quantity piped from other wells in Kansas and sold	1,696,429	1,159,759	745,205
Total sales in Kansas	2,409,521	1,801,781	1,263,764
Total value	$965,134	$746,695	$491,633

Well record.—The following tables give the well records for Kansas from 1905 to 1909, inclusive:

Number of wells completed in Kansas, 1905–1909, by counties.

County.	Completed.					Oil.				
	1905.	1906.	1907.	1908.	1909.	1905.	1906.	1907.	1908.	1909.
Allen	13	2	45	192	151	7		6	22	16
Anderson				9	1					
Bourbon		16					8			
Chautauqua	235	156	47	24	31	191	125	20	16	23
Elk	16	2			9	9	1			7
Franklin	63	72	16	2	7	55	63	9	1	
Labette	1	4			11		1			
Miami	246	38	10	6		197	25	5		
Montgomery	233	169	56	97	127	104	60	21	1	5
Neosho	155	165	112	118	100	97	68	7	30	18
Wilson	76	81	57	87	113	36	7			
Woodson					2					
Miscellaneous	239	74	25	31	6	121	8		2	
Total	1,277	779	368	566	558	817	306	68	72	69

County.	Gas.					Dry.				
	1905.	1906.	1907.	1908.	1909.	1905.	1906.	1907.	1908.	1909.
Allen	3	2	37	133	100	3		2	37	35
Anderson				9	1					
Bourbon		6					2			
Chautauqua	15	6	17	5	5	29	25	10	3	3
Elk	3				2	4	1			
Franklin	4	1	1		6	4	8	6	1	1
Labette		3			8	1				3
Miami	17	5	3	6		32	8	2		
Montgomery	89	88	31	79	100	40	21	4	17	22
Neosho	27	61	87	54	65	31	36	18	34	17
Wilson	24	48	47	66	89	16	26	10	21	24
Woodson					2					
Miscellaneous	67	42	13	15	5	51	24	12	14	1
Total	249	262	236	367	383	211	151	64	127	106

Number of wells completed in Kansas, 1905–1909, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1905	92	88	174	178	144	130	85	76	59	79	87	85	1,277
1906	81	64	63	64	94	73	75	77	49	50	39	50	779
1907	37	18	40	24	14	22	24	35	34	32	35	53	368
1908	37	45	48	32	47	59	45	31	53	62	54	53	566
1909	54	38	13	39	45	49	36	36	39	55	58	46	558

Number of dry holes drilled in Kansas, 1905–1909, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1905	14	16	18	33	29	28	18	9	7	15	12	12	211
1906	12	14	15	16	13	14	15	18	11	9	5	9	151
1907	10	3	4	5	3	4	2	6	4	8	7	8	64
1908	16	7	9	5	8	19	7	5	14	17	8	12	127
1909	14	8	11	7	6	8	9	7	6	13	12	5	106

Number of gas wells drilled in Kansas, 1905–1909, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1905	......	9	28	34	44	33	5	21	5	16	26	28	249
1906	18	23	15	24	23	15	15	27	22	19	27	34	262
1907	21	9	24	13	6	14	19	25	25	18	23	39	236
1908	19	33	37	22	32	32	27	17	36	41	36	35	367
1909	37	27	41	23	27	33	22	27	29	37	43	37	383

Total and average initial daily production of new wells in Kansas, 1905–1909, by counties, in barrels.

County.	Total initial production.					Average initial production per well.				
	1905.	1906.	1907.	1908.	1909.	1905.	1906.	1907.	1908.	1909.
Allen	75	....	89	365	251	10.7	....	14.8	16.6	15.7
Anderson	....	....	....	....	....	....	....	....	....	....
Bourbon	....	135	....	....	....	....	16.9	....	....	....
Chautauqua	5,865	2,920	358	305	475	30.7	23.4	17.9	19.1	20.7
Elk	124	10	....	....	110	13.8	10	....	....	15.7
Franklin	773	597	95	8	....	14.1	9.5	10.6	8.0	....
Labette	....	10	....	....	....	....	10	....	....	....
Miami	1,725	203	41	....	....	8.7	8.1	8.2	....	....
Montgomery	2,373	854	213	15	113	22.8	14.2	10.1	15.0	22.6
Neosho	1,143	802	90	446	360	11.8	11.8	12.9	14.9	20.0
Wilson	440	105	....	....	....	12.2	15.0	....	....	....
Woodson	....	....	....	....	....	....	....	....	....	....
Miscellaneous	2,033	125	....	20	....	16.8	15.6	....	10.0	....
Total	14,551	5,761	886	1,159	1,309	17.7	15.7	13.0	16.1	19.0

Total initial daily production of new wells in Kansas, 1905–1909, by months, in barrels.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1905	1,951	1,194	2,028	1,880	1,319	1,358	1,016	684	730	745	783	863	14,551
1906	946	528	528	442	722	765	637	472	252	272	85	112	5,761
1907	73	60	127	80	88	50	35	40	85	75	73	100	886
1908	65	100	40	85	105	120	170	138	55	80	96	105	1,159
1909	50	45	225	166	220	130	98	55	85	65	70	100	1,309

OKLAHOMA.

Production.—The following table shows the production and sales of petroleum in Oklahoma from 1907 to 1909:

Production of petroleum in Oklahoma, 1907–1909, in barrels.

	1907.	1908.	1909.
Estimated quantity shipped from Glenn pool and sold	19,926,995	20,494,313	18,946,740
Quantity piped from wells in Oklahoma to refineries	373,372	714,684	1,747,863
Estimated quantity piped from other wells in Oklahoma and sold	23,048,806	24,297,739	26,582,450
Rail shipments (outside Glenn pool) in Oklahoma	174,955	292,029	582,165
Total sales in Oklahoma	43,524,128	45,798,765	47,859,218
Total value	$17,513,524	$17,694,843	$17,428,990

There are approximately 125 oil-producing properties in Osage County, Okla. The following table gives a statement of the quantity of petroleum produced by the Indian Territory Illuminating Oil Company, and its sublessees, from wells in Osage County from 1903 to 1909, inclusive.

Production of petroleum by the Indian Territory Illuminating Oil Company and its sublessees, from January 1, 1903, to December 31, 1909.

	Barrels.		Barrels.
1903	56,905	1907	5,143,971
1904	652,479	1908	4,961,147
1905	3,421,478	1909	4,516,524
1906	5,219,106		

The total quantity and the value of the petroleum from wells in Osage County during the year 1909 were as follows:

Quantity and value of petroleum from wells in Osage County, 1909, in barrels.

	Quantity.	Value.
Prairie Oil and Gas Co	4,468,908	$1,691,518
Uncle Sam Oil Co	38,866	15,935
Southwestern Refining Co	4,461	2,218
Sold for fuel	7	3
Loss by fire	4,282	1,508
Total	4,516,524	1,711,182

The royalty interest of Osage County for 1909 amounted to 564,566 barrels of petroleum, valued at $213,898.

In the following table is shown the number of wells drilled in Osage County by the Indian Territory Illuminating Oil Company and its sublessees from 1903 to 1909, inclusive.

Oil and gas wells in Osage County, 1903–1909.

Total wells completed to—	Completed.	Productive.	Gas.	Dry.
Jan. 1, 1903	30	17	2	11
Dec. 31, 1904	361	243	21	97
June 10, 1905	544	355	34	155
Dec. 31, 1905	704	462	45	197
June 10, 1906	862	569	55	238
Dec. 31, 1906	1,080	716	66	298
June 30, 1907	1,155	779	67	309
Dec. 31, 1907	1,277	837	71	369
Dec. 31, 1908	1,422	936	78	408
Dec. 31, 1909	1,574	1,027	81	466

In the following table is given the production of petroleum in the lenn pool (Creek County) for the last three years:

stimated production and sales of petroleum from Glenn pool in 1907–1909, by months, in barrels.

Month.	1907.	1908.	1909.
nuary	385,939	1,796,461	1,362,602
bruary	572,414	1,897,054	1,410,878
rch	1,084,636	2,098,411	1,543,463
ril	1,716,079	1,968,761	1,467,179
y	1,923,262	1,630,111	1,590,730
ne	1,971,122	1,051,045	1,809,989
ly	1,922,387	1,914,134	1,856,524
gust	2,003,607	1,770,819	1,699,486
ptember	2,309,205	1,639,252	1,670,167
tober	2,441,622	1,832,033	1,602,988
vember	1,971,595	1,404,234	1,539,342
cember	1,625,127	1,491,998	1,393,392
Total	19,926,995	20,494,313	18,946,740

Well record.—The following table gives the well record for Oklahoma for 1909, by districts and pools:

Well record in Oklahoma in 1909, by districts and pools.

District and pool.	Wells completed.				Initial daily production.	
	Total.	Oil.	Dry.	Gas.	Total.	Average per well.
					Barrels.	*Barrels.*
erokee, deep sand	652	519	62	71	34,130	65.8
Bartlesville	254	238	11	5	11,475	48.2
Bird Creek	101	78	17	6	3,595	46.1
Copan	95	43	17	35	2,340	54.4
Flat Rock	95	89	5	1	12,970	145.7
Hogshooter	107	71	12	24	3,750	50.0
erokee, shallow sand	1,724	1,535	169	20	90,864	59.2
Alluwe	246	222	24		7,196	32.4
Catoosa	4	3	1		70	23.3
Chelsea	262	224	38		7,405	33.1
Claremore	2	2			13	6.5
Coody's Bluff	72	69	3		1,565	22.7
Collinsville	11		2	9		
Delaware-Childers	546	475	65	6	57,320	120.7
Dewey	161	152	8	1	5,065	33.3
Nowata	232	213	15	4	5,620	26.4
Ochelata	92	81	11		2,805	34.6
Salt Creek	96	94	2		3,805	40.5
eveland	28	23	3	2	1,865	81.1
eek	733	582	114	37	68,710	118.1
Beggs	2		2			
Glenn Pool	89	80	5	4	6,240	78.0
Haskell	10	5	5		460	92.0
Morris-Okmulgee	39	14	22	3	2,010	143.6
Mounds	11		10	1		
Muskogee	129	79	41	9	8,245	104.4
Preston	9	8		1	2,300	287.5
Redfork	5	3	2		35	11.7
Sapulpa	10	7	3		150	21.4
Taneha	357	332	19	6	43,130	129.9
Tulsa	6	3	1	2	45	15.0
Twin Hills	66	51	4	11	6,095	119.5
sage	108	75	15	18	10,205	136.1
iscellaneous	34	8	17	9	680	85.0
Total	3,279	2,742	380	157	206,454	75.3

Number of wells completed in Oklahoma, 1905–1909, by districts.

District.	Completed.					Dry.					Gas.					Oil.				
	1905.	1906.	1907.	1908.	1909.	1905.	1906.	1907.	1908.	1909.	1905.	1906.	1907.	1908.	1909.	1905.	1906.	1907.	1908.	1909.
Cherokee, deep	.....	.....	941	690	652	...	...	65	53	62	...	...	61	32	71	.....	.....	815	605	519
Bartlesville	273	790	.....	.....	.....	33	123	...	...	...	15	61	...	...	...	225	606	.....	.....	.....
Cherokee, shallow	.....	.....	1,537	1,281	1,724	...	...	120	94	169	...	...	14	7	20	.....	.....	1,403	1,180	1,535
Alluwe	165	441	.....	.....	.....	4	25	...	...	...	1	7	...	...	...	160	409	.....	.....	.....
Chelsea	244	400	.....	.....	.....	20	44	...	...	...	6	8	...	...	...	218	348	.....	.....	.....
Coodys Bluff	280	549	.....	.....	.....	8	28	...	...	...	10	11	...	...	...	262	510	.....	.....	.....
Creek	151	211	1,225	683	733	33	41	97	106	114	21	35	38	52	37	97	135	1,090	525	582
Oklahoma	334	107	36	.....	.....	47	50	12	...	...	10	19	8	...	...	277	38	16	.....	.....
Cleveland	.....	.....	.....	22	28	...	...	...	7	3	...	...	...	1	2	.....	.....	.....	14	23
Osage	482	262	184	153	108	107	30	15	16	15	16	17	15	8	18	359	215	154	129	75
Miscellaneous	581	19	33	15	34	101	7	9	8	17	19	5	12	2	9	461	7	12	5	8
Total	2,510	2,779	3,956	2,844	3,279	353	348	318	284	380	98	163	148	102	157	2,059	2,268	3,490	2,458	2,742

Number of wells completed in Oklahoma, 1905–1909, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1905	59	79	174	211	231	172	195	237	221	246	305	380	2,510
1906	310	285	217	258	404	337	218	222	142	110	96	180	2,779
1907	153	174	249	404	356	362	399	364	439	464	351	241	3,956
1908	194	162	165	194	229	208	224	282	246	263	325	352	2,844
1909	310	288	345	388	374	279	243	239	205	198	200	210	3,279

Number of dry holes drilled in Oklahoma, 1905–1909, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1905	13	14	33	45	39	30	30	30	26	23	39	31	353
1906	35	41	29	25	39	40	29	32	19	30	9	20	348
1907	13	15	17	24	27	32	43	32	33	31	31	20	318
1908	23	11	21	24	22	25	18	38	28	21	25	28	284
1909	33	22	38	51	53	48	31	28	14	17	21	24	380

Number of gas wells drilled in Oklahoma, 1905–1909, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1905	.....	4	3	8	6	14	9	17	6	10	15	6	98
1906	9	17	12	16	19	24	7	14	17	10	4	14	163
1907	9	14	13	12	16	12	13	10	10	16	14	9	148
1908	16	8	8	9	7	5	7	8	11	3	13	7	102
1909	6	6	11	7	12	8	9	9	11	14	32	32	157

Total and average initial daily production of new wells in Oklahoma, 1905–1909, by districts, in barrels.

District.	Total initial production.					Average initial production per well.				
	1905.	1906.	1907.	1908.	1909.	1905.	1906.	1907.	1908.	1909.
Cherokee, deep.	....	....	74,824	36,561	34,130	....	....	91.8	60.4	65.8
Bartlesville	14,780	44,367	....	....	....	65.7	73.2	....	....	....
Cherokee, shallow	....	....	64,490	80,923	90,864	....	....	45.9	68.6	59.2
Alluwe	5,116	13,749	....	....	....	31.9	33.6	....	....	....
Chelsea	3,960	6,828	....	....	....	18.1	19.6	....	....	....
Coodys Bluff	7,160	22,845	....	....	....	27.3	44.8	....	....	....
Creek	3,108	51,728	303,005	76,722	68,710	32.0	383.2	277.9	146.1	118.1
Oklahoma	23,178	1,562	534	....	....	83.7	41.1	33.4	....	....
Cleveland	....	....	....	455	1,865	....	....	....	32.5	81.1
Osage	36,423	20,047	16,355	19,377	10,205	101.5	93.2	106.2	150.2	136.1
Miscellaneous	17,665	160	654	114	680	38.3	22.9	54.5	22.8	85.0
Total	111,390	161,286	459,862	214,152	206,454	54.1	71.1	131.7	87.1	75.3

Total initial daily production of new wells in Oklahoma, 1905–1909, by months, in barrels.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1905	4,982	4,395	7,636	8,340	8,415	8,665	13,737	10,905	8,918	9,207	11,285	14,905	111,390
1906	13,038	11,485	8,755	13,516	15,844	15,012	12,240	17,398	9,635	8,608	14,495	21,260	161,286
1907	17,700	21,829	29,063	36,690	52,157	47,697	44,683	40,166	55,371	46,643	41,608	26,255	459,862
1908	16,475	17,550	10,865	13,018	16,045	15,860	14,695	18,834	17,198	24,915	25,377	23,320	214,152
1909	21,745	21,820	21,220	20,910	21,020	18,120	16,350	15,480	14,190	11,683	12,225	11,691	206,454

GULF OIL FIELD.

PRODUCTION.

Louisiana showed a greater percentage of decline—47.15 per cent—than any other oil-producing State, and this in spite of increased production in the Caddo field in the northwestern corner of the State. The total production for Louisiana was 3,059,531 barrels in 1909 against 5,788,874 barrels in 1908. The increase in the Caddo field began late in the year and has been much greater in 1910, with the development of an important extension on the western edge reaching into Texas. Prospecting has been active in eastern and northern Louisiana, but has not proceeded far enough to be decisive.

In coastal Texas the decline was proportionately greater than in 1908, the production reaching only 8,852,527 barrels in 1909 against 10,483,200 barrels in 1908.

In the table following is given the production in the Gulf field in 1908 and 1909, by months.

Production of petroleum in the Gulf field in 1908 and 1909, by months, in barrels.

Month.	1908.			1909.		
	Coastal Texas.	Louisiana.	Total.	Coastal Texas.	Louisiana.	Total.
January	896,547	591,146	1,487,693	856,861	301,729	1,158,590
February	852,059	467,182	1,319,241	775,234	265,434	1,040,668
March	977,296	550,765	1,528,061	804,045	288,099	1,092,144
April	842,737	627,248	1,469,985	745,395	227,710	973,105
May	873,944	625,130	1,499,074	769,004	247,590	1,016,594
June	823,940	476,506	1,300,446	730,123	237,034	967,157
July	855,277	499,427	1,354,704	742,755	245,158	987,913
August	841,738	415,158	1,256,896	714,256	249,481	963,737
September	813,771	411,539	1,225,310	682,984	218,008	900,992
October	881,792	426,313	1,308,105	678,385	229,617	908,002
November	877,074	354,452	1,231,526	683,207	265,137	948,344
December	947,025	344,008	1,291,033	670,278	284,534	954,812
Total	10,483,200	5,788,874	16,272,074	8,852,527	3,059,531	11,912,058

Production and value of petroleum produced in the Gulf field, 1901–1909, by States, in barrels.

Year.	Coastal Texas.		Louisiana.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1901	3,593,113	$630,752			3,593,113	$630,752
1902	17,465,787	3,577,698	548,617	$188,985	18,014,404	3,766,683
1903	17,453,612	7,002,165	917,771	416,228	18,371,383	7,418,393
1904	21,672,311	7,743,860	2,958,958	1,073,594	24,631,269	8,817,454
1905	27,615,907	7,190,658	8,910,416	1,601,325	36,526,323	8,791,983
1906	11,449,992	5,825,036	9,077,528	3,557,838	20,527,520	9,382,874
1907	11,410,078	9,680,286	5,000,221	4,063,033	16,410,299	13,743,319
1908	10,483,200	6,221,636	5,788,874	3,503,419	16,272,074	9,725,055
1909	8,852,527	6,399,318	3,059,531	2,022,449	11,912,058	8,421,767

In the following table is shown the production of petroleum in the Gulf field from 1889 to 1909, with its percentage of the total of the United States, the increase or decrease each year, and the percentage of increase or decrease:

Production of petroleum in the Gulf field, 1889–1909, in barrels.

Year.	Production.	Per cent of total production.	Increase.	Decrease.	Per cent.	
					Increase.	Decrease.
1889	48					
1890	54		6		12.50	
1891	54					
1892	45			9		16.67
1893	50		5		11.11	
1894	60		10		20.00	
1895	50			10		16.67
1896	50					
1897	50					
1898	1,450		1,400		2,800.00	
1899	530			920		63.45
1900	0			530		100.00
1901	3,593,113	5.18	3,593,113			
1902	18,014,404	20.29	14,421,291		401.36	
1903	18,371,383	18.29	356,979		1.98	
1904	24,631,269	21.03	6,259,886		34.07	
1905	36,526,323	27.11	11,895,054		48.29	
1906	20,527,520	16.23		15,998,803		43.80
1907	16,470,299	9.88		4,117,221		20.05
1908	16,272,074	9.11		138,225		.84
1909	11,912,058	6.54		4,360,016		26.79

TEXAS.

PRODUCTION.

Production and value of petroleum in northern and coastal Texas, 1900–1909, in barrels.

Year.	Northern Texas.		Coastal Texas.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1900	836,039	$871,996	....	....	836,039	$871,996
1901	800,545	616,397	3,593,113	$630,753	4,393,658	1,247,149
1902	617,871	420,399	17,465,787	3,577,698	18,083,658	3,998,097
1903	501,960	515,314	17,453,612	7,002,165	17,955,572	7,517,479
1904	569,102	412,360	21,672,311	7,743,860	22,241,413	8,152,220
1905	520,282	361,604	27,615,907	7,190,658	28,136,187	7,552,262
1906	1,117,905	740,542	11,449,992	5,825,036	12,567,897	6,565,578
1907	912,618	721,577	11,410,078	9,680,286	12,322,696	10,401,863
1908	723,264	479,072	10,483,200	6,221,636	11,206,464	6,700,708
1909	681,940	393,732	8,852,527	6,399,318	9,534,467	6,793,050

In the following table will be found the production of petroleum in Texas, by districts and months, for the years 1908 and 1909:

Production of petroleum in Texas, 1908–9, by districts and months, in barrels.

1908.

Month.	Northern Texas.				Coastal Texas.	
	Corsicana.	Henrietta.	Powell.	Total.[a]	Batson.	Dayton.
January	25,670	6,103	42,189	74,374	147,131	2,564
February	26,179	6,377	43,423	76,391	147,108	3,298
March	15,620	7,018	38,681	61,731	159,143	3,553
April	15,443	6,803	36,998	59,656	132,413	3,262
May	14,730	6,023	37,065	58,230	144,212	2,625
June	16,694	6,470	36,888	60,464	128,580	2,117
July	14,953	6,154	35,456	56,875	136,086	2,823
August	16,783	8,149	33,249	58,493	131,100	5,374
September	16,158	7,311	34,861	58,642	116,224	2,980
October	16,766	7,188	28,849	53,115	120,291	4,242
November	16,089	8,977	26,935	52,313	115,553	3,711
December	16,032	9,390	27,065	52,980	115,729	3,352
Total	211,117	85,963	421,659	723,264	1,593,570	39,901

Month.	Coastal Texas.						Total.
	Humble.	Saratoga.	Sour Lake.	Spindle Top.	Other.[b]	Total.	
January	287,773	153,010	143,352	160,067	2,650	896,547	970,921
February	251,885	151,283	150,325	145,873	2,287	852,059	928,450
March	272,043	195,176	163,071	182,460	1,850	977,296	1,039,027
April	248,531	153,558	137,548	166,581	844	842,737	902,393
May	280,847	141,602	130,205	173,803	650	873,944	932,174
June	288,546	134,927	125,942	141,384	2,444	823,940	884,404
July	312,065	120,504	125,613	145,751	12,435	855,277	912,152
August	304,367	126,866	128,342	130,871	14,818	841,738	900,231
September	311,429	118,946	119,726	120,649	23,817	813,771	872,413
October	375,957	117,286	124,821	126,620	12,575	881,792	934,907
November	394,765	108,023	119,417	126,060	9,545	877,074	929,387
December	450,313	113,605	126,698	127,418	9,910	947,025	1,000,005
Total	3,778,521	1,634,786	1,595,060	1,747,537	93,825	10,483,200	11,206,464

[a] Includes South Bosque and Jack County.
[b] Includes Goose Creek, Hoskins Mound, Matagorda County, Piedras Pintas, and Mission fields.

Production of petroleum in Texas, 1908–9, by districts and months, in barrels—Contd.

1909.

Month.	Northern Texas.				Coastal Texas.	
	Corsicana.	Henrietta.	Powell.	Total.[a]	Batson.	Humble.
January	15,517	9,202	30,628	55,723	104,635	359,327
February	11,857	8,371	27,796	48,400	97,907	340,189
March	15,589	8,866	29,601	54,432	103,826	303,327
April	14,226	8,512	29,211	52,325	106,080	281,930
May	14,780	8,776	26,928	50,860	103,328	282,868
June	13,824	7,906	30,803	52,909	98,430	263,600
July	14,292	9,458	31,821	55,947	98,017	243,606
August	13,843	10,218	32,419	56,856	105,236	235,544
September	13,523	10,026	34,523	58,448	94,877	226,443
October	13,103	10,509	35,679	59,667	99,693	225,948
November	27,406	10,805	36,991	75,578	99,372	244,094
December	12,804	10,836	36,737	60,795	94,813	230,184
Total	180,764	113,485	383,137	681,940	1,206,214	3,237,060

Month.	Coastal Texas.					Total.
	Saratoga.	Sour Lake.	Spindletop.	Other.[b]	Total.	
January	109,948	142,454	125,733	14,764	856,861	912,584
February	82,799	130,793	109,695	13,851	775,234	823,634
March	102,144	158,244	123,062	13,442	804,045	858,477
April	94,615	135,356	116,587	10,827	745,395	797,720
May	98,079	144,234	127,118	13,377	769,004	819,864
June	91,334	157,620	105,971	13,168	730,123	783,032
July	99,471	179,710	111,015	10,936	742,755	798,702
August	96,116	152,567	115,573	9,220	714,256	771,112
September	98,092	142,374	113,683	7,515	682,984	741,432
October	96,786	130,438	117,249	8,271	678,385	738,052
November	101,810	120,285	110,317	7,329	683,207	758,785
December	112,365	109,723	112,104	11,089	670,278	731,073
Total	1,183,559	1,703,798	1,388,107	133,789	8,852,527	9,534,467

[a] Includes South Bosque and Brown County.
[b] Includes Dayton, Goose Creek, Hoskins Mound, Matagorda County, Piedras Pintas, and Mission fields.

The production of petroleum in Texas from 1900 to 1909, inclusive, has been as follows:

Production of petroleum in Texas, 1900–1909, by districts, in barrels.

Year.	Northern Texas.				Coastal Texas.		
	Corsicana.	Henrietta.	Powell.	Total.[a]	Batson.	Dayton.	Humble.
1900	829,560	....	6,479	836,039	....	....	....
1901	763,424	....	37,121	800,545	....	....	....
1902	571,059	....	46,812	617,871	....	....	....
1903	401,817	....	100,143	501,960	4,518	....	....
1904	374,318	65,455	129,329	569,252	10,904,737	....	....
1905	311,554	75,592	132,866	520,282	3,774,841	60,294	15,594,310
1906	332,622	111,072	673,221	1,117,905	2,289,507	92,850	3,571,445
1907	226,311	83,260	596,897	912,618	2,164,453	108,038	2,929,640
1908	211,117	85,963	421,659	723,264	1,593,570	39,901	3,778,521
1909	180,764	113,485	383,137	681,940	1,206,214	17,647	3,237,060

Production of petroleum in Texas, 1900–1909, by districts, in barrels—Continued.

Year.	Coastal Texas.						Total.
	Matagorda County.	Saratoga.	Sour Lake.	Spindle-top.	Other.	Total.	
1900	....	....	....			....	836,039
1901	....	....	....	3,593,113	....	3,593,113	4,393,658
1902	....	44,838		17,420,949	....	17,465,787	18,083,658
1903	....	8,848,159		8,600,905	b 30	17,453,612	17,955,572
1904	151,936	739,239	6,442,357	3,433,842	b 50	21,672,161	22,241,413
1905	46,471	3,125,028	3,362,153	1,652,780	b 30	27,615,907	28,136,189
1906	3,600	2,182,057	2,156,010	1,077,492	77,031	11,449,992	12,567,897
1907	1,573	2,130,928	2,353,940	1,699,943	21,563	11,410,078	12,322,696
1908	62,640	1,634,786	1,595,060	1,747,537	31,185	10,483,200	11,206,464
1909	29,103	1,183,559	1,703,798	1,388,107	87,039	8,852,527	9,534,467

a Includes other districts of northern Texas.

b Bexar County.

The following table gives a statement of the production and value of petroleum at wells in Texas in 1908 and 1909, by districts:

Production and value of petroleum in Texas, in 1908 and 1909, by districts, in barrels.

District.	1908.			1909.		
	Quantity.	Value.	Price per barrel.	Quantity.	Value.	Price per barrel.
Northern Texas:						
Corsicana	211,117	$153,489	$0.727	180,764	$130,335	$0.721
Henrietta	85,963	46,947	.546	113,485	58,694	.517
Powell	421,659	274,536	.651	383,137	199,952	.522
Coastal Texas:						
Batson	1,593,570	885,965	.556	1,206,214	851,138	.706
Dayton	39,901	19,818	.497	17,647	11,471	.65
Humble	3,778,521	2,269,341	.600	3,237,060	2,314,082	.715
Matagorda	a 77,640	33,267	.429	29,103	21,918	.753
Saratoga	1,634,786	989,167	.605	1,183,559	864,938	.738
Sour Lake	1,595,060	982,769	.616	1,703,798	1,227,734	.721
Spindletop	1,747,537	1,030,403	.589	1,388,107	1,041,791	.751
Other Texas	b 20,710	15,006	.725	c 91,593	70,997	.775
Total	11,206,464	6,700,708	.598	9,534,467	6,793,050	.712

a Includes the production of Goose Creek.

b Includes a small production from northern Texas and from the counties of Bexar, Brazoria, Clay, Duval, and McLennan.

c Includes South Bosque and small production in Brown County in northern Texas and Hoskins Mound, Piedras Pintas, and Mission fields in coastal Texas.

PRICES.

In the following table are given the fluctuation in prices per barrel for the various grades of petroleum produced in northern Texas in the years 1907 to 1909, inclusive:

Fluctuation in prices per barrel of petroleum in northern Texas, 1907–1909.

Corsicana.		Henrietta.		Powell.	
1907.		1907.		1907.	
January 1	$1.00	January 1	$0.95	January 1	$0.65
February 11	1.02	December 1	.93	January 26	.70
December 1	1.00				
		1908.		1908.	
1908.		January 1	.93	January 1	.70
January 1	1.00	February 1	.90	March 16	.67
February 1	.98	March 1	.85	March 30	.65
March 1	.95	March 16	.80	April 24	.62
March 16	.90	March 30	.75	April 28	.60
March 30	.85	April 24	.70	May 16	.57
April 24	.82	June 4	.65	June 4	.55
April 28	.80	June 10	.60	June 10	.50
May 16	.77	June 13	.45	June 13	.45
June 4	.75	October 14	.48	October 14	.48
June 10	.72				
June 13	.70	1909.		1909.	
		January 1	.48	January 1	.48
1909.		March 13	.50	March 13	.50
January 1	.70	April 27	.53	April 27	.53

The average monthly prices per barrel of petroleum at wells in northern Texas in the years 1907 to 1909, inclusive, were as follows:

Average monthly prices per barrel of petroleum in northern Texas, 1907–1909.

Month.	Corsicana.			Henrietta.			Powell.		
	1907.	1908.	1909.	1907.	1908.	1909.	1907.	1908.	1909.
January	$1.00	$1.00	$0.70	$0.95	$0.93	$0.48	$0.65	$0.70	$0.48
February	$1.00– 1.02	.98	.70	.95	.90	.48	.65	.70	.48
March	1.02	$0.85– .95	.70	.95	$0.75– .85	.49⅛	.70	$0.65– .70	.49⅛
April	1.02	.80– .85	.70	.95	.70– .75	.50½	.70	.60– .65	.50½
May	1.02	.77– .80	.70	.95	.70	.53	.70	.57– .60	.53
June	1.02	.70– .77	.70	.95	.45– .70	.53	.70	.45– .57	.53
July	1.02	.70	.70	.95	.45	.53	.70	.45	.53
August	1.02	.70	.70	.95	.45	.53	.70	.45	.53
September	1.02	.70	.70	.95	.45	.53	.70	.45	.53
October	1.02	.70	.70	.95	.45– .48	.53	.70	.45– .48	.53
November	1.02	.70	.70	.95	.48	.53	.70	.48	.53
December	1.02	.70	.70	.93	.48	.53	.70	.48	.53
Average	1.011	.727	.70	.948	.546	.51⅝	.682	.65	.51⅝

The average monthly prices per barrel of petroleum at wells in coastal Texas in the years 1907 to 1909, inclusive, were as follows:

Average monthly prices per barrel of petroleum in coastal Texas, 1907–1909.

Month.	Batson.			Dayton.		
	1907	1908	1909	1907	1908	1909
January	$0.72–$0.75	$0.66–$0.84	$0.53–$0.60	$0.65–$0.69	$0.61	$0.50
February	.77– .80	.68– .73	.53– .60	.65– .73	.60	.50
March	.80– .85	.67– .71	.53– .65	.73	.60	.50
April	.81– .85	.63	.66– .73	.73	.57	.60
May	.82– .90	.53– .58	.73	.73	.50	.70
June	.81– .93	.47– .51	.73	.75	.44	.70
July	.88– .93	.40	.74– .75	.75	.36	.71
August	.92– .93	.40– .43	.75	.76	.38	.72
September	.92– .95	.44– .46	.75	.86	.41	.72
October	.92– .95	.44– .52	.75– .77	.85	.48	.72
November	.92– .95	.54– .55	.75– .77	.84	.51	.72
December	.88– .95	.53	.75– .77	.72	.50	.72
Average	.884	.556	.706	.746	.497	.65

Month.	Humble.			Saratoga.		
	1907	1908	1909	1907	1908	1909
January	$0.62–$0.77	$0.68 –$0.913	$0.54–$0.60	$0.66–$0.75	$0.66 –$0.887	$0.53 –$0.60
February	.69– .80	.725– .893	.54– .65	.69– .80	.70 – .725	.53 – .65
March	.74– .90	.69 – .869	.54– .70	.72– .85	.70 – .725	.53 – .65
April	.76– .90	.66 – .869	.65– .75	.75– .85	.64 – .725	.60 – .73
May	.76– .91	.60 – .725	.73– .75	.78– .90	.54 – .725	.725– .73
June	.76– .94	.51 – .725	.74– .75	.78– .93	.48 – .725	.725– .73
July	.80– .95	.43 – .482	.74– .75	.81– .93	.40 – .681	.725– .75
August	.81– .99	.44 – .45	.75	.84– .93	.43 – .45	.75
September	.81– .97	.436– .50	.75	.85– .92	.449– .46	.75
October	.82– .97	.497– .57	.75– .78	.80– .94	.451– .55	.75 – .80
November	.77– .95	.517– .56	.75– .80	.75– .92	.547– .55	.75 – .80
December	.70– .95	.533– .55	.75– .80	.74– .94	.53 – .55	.75 – .80
Average	.839	.60	.715	.818	.605	.738

Month.	Sour Lake.			Spindle Top.		
	1907	1908	1909	1907	1908	1909
January	$0.65½–$0.76	$0.69 –$0.92	$0.54–$0.60	$0.72–$0.78	$0.71 –$0.791	$0.58–$0.60
February	.72 – .80	.70 – .807	.54– .65	.78– .80	.70 – .717	.60– .65
March	.74 – .85	.70 – .725	.54– .70	.81– .85	.69 – .713	.60– .70
April	.79 – .90	.64 – .725	.65– .75	.83– .875	.64 – .687	.68– .75
May	.79 – .90	.57 – .725	.75	.83– .89	.57 – .646	.75
June	.79 – .90	.51 – .725	.75	.85– .93	.48 – .568	.75
July	.80 – .93	.43 – .688	.75– .76	.88– .95	.408– .43	.77– .80
August	.88 – .93	.44 – .45	.75– .77	.93– .97	.44 – .45	.80
September	.89 – .97	.44 – .47	.75– .77	.94– .97	.462– .50	.80
October	.84 – .97	.448– .55	.77– .80	.94– .98	.54 – .57	.80– .82
November	.79 – .97	.55 – .552	.77– .80	.85– .97	.56 – .573	.80– .82
December	.78 – .97	.533– .55	.77– .80	.70– .97	.58 – .60	.80– .82
Average	.826	.616	.721	.895	.589	.751

WELL RECORD IN NORTHERN TEXAS.

The following tables give the well records in northern Texas from 1907 to 1909, inclusive:

Number of wells completed in northern Texas, 1907–1909, by districts.

District.	Completed.			Dry.			Oil.		
	1907	1908	1909	1907	1908	1909	1907	1908	1909
Corsicana	16	13	5	4	5	1	12	8	4
Henrietta	27	26	46	9	7	a 26	18	19	20
Powell	104	42	118	42	12	b 31	62	30	87
South Bosque	26	....	2	12	....	1	14	....	1
Other	....	....	4	....	....	....	....	....	4
Total	173	81	175	67	24	59	106	57	116

a Eleven gas. b Three gas.

Number of wells completed in northern Texas, 1907–1909, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1907	19	14	17	14	12	16	14	14	9	13	4	10	a 173
1908	3	8	6	11	5	7	5	6	5	10	7	8	81
1909	6	4	......	8	22	20	21	11	19	14	31	13	a 175

a South Bosque not reported by months.

Number of dry holes drilled in northern Texas, 1907–1909, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1907	9	5	4	5	4	5	6	7	6	6	4	6	67
1908	1	1	1	4	1	3	2	2	3	3	1	2	24
1909	6	2	......	4	4	5	4	4	7	4	11	7	59

Total and average initial daily production of new wells in northern Texas, 1907–1909, by districts, in barrels.

District.	Total initial production.			Average initial production per well.		
	1907.	1908.	1909.	1907.	1908.	1909.
Corsicana	36	41	25	3.0	5.1	6.2
Henrietta	222	718	484	12.3	37.8	24.2
Powell	830	368	668	13.4	12.3	7.8
South Bosque	59	....	....	4.2	....	....
Total	1,147	1,127	1,177	10.8	19.8	10.8

Total initial daily production of new wells in northern Texas, 1907–1909, by months, in barrels.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1907	135	125	260	100	95	120	103	53	30	20	......	47	a 1,147
1908	10	22	177	30	17	17	34	135	155	230	205	95	1,127
1909	0	50	0	45	117	133	227	73	74	154	248	56	1,177

a South Bosque not reported by months.

WELL RECORD IN COASTAL TEXAS.

The following tables give the well records in coastal Texas from 1906 to 1909, inclusive:

Number of wells completed in coastal Texas, 1906–1909, by districts.

District.	Completed.				Dry.				Oil.			
	1906.	1907.	1908.	1909.	1906.	1907.	1908.	1909.	1906.	1907.	1908.	1909.
Batson	80	206	53	51	4	32	10	11	76	174	43	40
Dayton	7	18	8	4	3	7	6	4	4	11	2	0
Goose Creek	......	......	5	7	......	......	3	2	......	......	2	5
Hoskins Mound[a]	6	3	8	2	5	3	6	1	1	......	2	1
Humble	345	269	281	201	123	[b] 99	[c] 80	[d] 72	222	170	201	129
Markham	......	......	10	2	......	......	5	......	......	......	5	2
Matagorda	......	6	......	......	......	5	......	......	......	1	......	......
Mission	......	7	5	......	......	4	2	......	......	3	3	......
Piedras Pintas	......	4	......	12	......	......	......	10	......	4	......	2
Saratoga	64	98	44	31	9	12	4	4	55	86	40	27
Sourlake	74	156	81	146	20	[e] 36	[e] 9	[e] 30	54	120	72	116
Spindletop	68	122	108	82	29	21	26	36	39	101	82	46
West Columbia[f]	......	......	......	......	......	......	......	......	......	......	......	......
	644	889	603	538	193	219	151	170	451	670	452	368

[a] Includes West Columbia.
[b] 10 gas wells.
[c] 7 gas wells.
[d] 8 gas wells.
[e] 1 gas well.
[f] Included with Hoskins Mound.

Number of wells completed in coastal Tex., 1906–1909, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1906	38	30	35	65	90	115	74	49	42	32	33	31	634
1907	68	63	97	85	52	74	69	73	81	86	77	44	869
1908	46	69	64	49	55	44	32	31	46	49	48	57	590
1909	48	51	54	49	52	35	45	52	45	37	38	32	538

Number of dry holes drilled in coastal Texas, 1906–1909, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1906	14	12	12	26	27	40	13	16	13	4	3	6	186
1907	18	13	17	5	8	24	15	20	19	38	23	7	207
1908	10	16	16	8	10	23	12	10	12	6	7	13	143
1909	18	11	18	16	16	11	10	17	15	16	8	14	170

Total and average initial daily production of new wells in coastal Texas, 1906–1909, by districts, in barrels.

District.	Total initial production.				Average initial production per well.			
	1906.	1907.	1908.	1909.	1906.	1907.	1908.	1909.
Batson	3,935	18,004	2,806	2,179	87.4	103.5	65.2	54
Dayton	200	730	90	......	100	66.3	45	......
Goose Creek	......	......	500	54	......	......	250	11
Hoskins Mound	......	......	......	20	......	......	......	20
Humble	5,560	30,643	46,260	8,645	79.4	180.2	230.1	67
Markham	......	......	2,700	175	......	......	540	87
Piedras Pintas	......	......	......	175	......	......	......	87
Saratoga	5,565	11,487	5,135	3,590	154.6	133.5	128.4	13.3
Sour Lake	5,570	12,481	7,376	12,737	192.1	104	102.4	11
Spindletop	2,275	10,452	9,385	5,725	94.8	103.5	114.4	12.4
Total	[a]23,105	83,797	74,252	33,300	112.1	126.6	166.1	89.7

[a] Six months.

Total initial daily production of new wells in costal Texas, 1906–1909, by months, in barrels.

Year.	Jan.	Feb.	Mar.	Apr.	May.	une.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1906....	....	....	....	....	....	....	5,915	2,950	2,530	4,020	3,180	4,510	23,105
1907....	5,025	10,525	14,630	13,845	5,235	3,599	4,585	4,069	5,565	4,289	8,530	3,900	83,797
1908....	6,200	6,040	6,045	5,100	4,565	5,435	5,835	5,485	6,865	6,117	9,020	7,545	74,252
1909....	2,180	4,160	3,155	2,577	3,090	2,520	4,615	3,285	2,955	1,459	2,334	970	33,300

SHIPMENTS.

In the following table is given the shipment of petroleum by railroad in tank cars from the different stations of Texas during the year 1909:

Quantity of petroleum shipped by railroad in tank cars from the oil fields of Texas, at the stations named, by months, during the year 1909, in barrels.

Month.	Beaumont, Gladys.	Corsicana.[a]	Danbury, Markham, Noledo.	Houston, Trice.	Humble.	Saratoga.	Sour Lake.	Total.[b]
January..............	2,364	9,144	3,120	108,009	242,069	54,551	95,186	514,443
February............	3,281	9,144	2,863	65,310	152,606	55,653	145,040	433,897
March...............	1,646	9,144	3,683	74,235	142,701	31,555	124,513	387,477
April.................	3,038	9,144	1,420	84,909	117,149	28,918	52,714	297,292
May..................	65,398	9,144	5,440	85,474	268,735	25,213	102,849	562,253
June.................	68,231	9,144	8,222	89,941	127,658	21,081	97,123	421,400
July..................	62,636	9,144	2,037	80,893	133,601	37,647	56,896	382,854
August...............	59,133	9,144	4,451	94,360	139,719	8,784	52,589	368,180
September..........	65,976	9,144	4,118	90,735	96,173	1,400	20,953	288,499
October.............	17,469	9,144	7,911	86,000	103,730	252	17,024	241,530
November...........	79,585	9,144	5,424	60,088	113,828	....	29,026	297,095
December...........	28,040	9,142	2,321	64,908	113,979	....	20,453	238,843
Total..........	456,797	109,726	51,010	984,862	1,751,948	265,054	814,366	4,433,763

[a] Averaged.
[b] In addition 22,630 barrels of crude oil were shipped from Port Arthur and 1,760 barrels from Port Neches.

NOTE.—These are the official figures furnished by the railroads which shipped the crude petroleum. Calculations were made in reduction of pounds to barrels on the basis of 310.8 pounds to a barrel.

EXPORTS.

The following tables, furnished by the Bureau of Statistics, Department of Commerce and Labor, give the exports of crude petroleum and its products from Texas, by months and kinds and by customs districts:

Exports to foreign countries of crude and refined petroleum from all ports of Texas in calendar year 1909, by months, in gallons.

Month.	Crude.		Naphtha.		Illuminating.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
January..................	5,948,083	$156,802	11,841	$1,938	8,438,585	$405,939
February................	2,026,840	60,803	9,228	1,452	3,605,616	163,532
March....................	6,183,805	200,714	9,003	1,362	6,678,574	301,869
April......................	5,578,008	188,297	7,636	1,080	5,429,851	244,648
May.......................	944,157	20,238	4,054	519	2,425,534	124,654
June......................	3,022,653	105,699	2,545,090	180,953	5,493,659	248,985
July.......................	2,008,494	43,037	11,265	1,272	8,467,446	388,246
August...................	973,850	20,878	4,861	632	3,750,684	170,240
September..............	2,783,893	59,277	3,900	578	4,540,657	244,644
October..................	3,197,649	79,039	32,491	5,680	3,955,415	178,729
November...............	1,702,942	36,501	2.532	367	3,200,516	144,619
December...............	2,707,964	60,352	·1,122,261	67,591	4,772,359	216,591
Total.............	37,078,338	1,031,637	3,764,162	263,424	60,758,896	2,832,696

Exports to foreign countries of crude and refined petroleum from all parts of Texas in calendar year 1909, by months, in gallons—Continued.

Month.	Lubricating and paraffin.		Residuum.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
January	42,569	$8,323	4,950,596	$172,697	19,391,674	$745,699
February	7,662	2,267	2,751,691	97,522	8,401,037	325,576
March	1,062,954	79,102	4,138,646	146,866	18,072,982	729,913
April	59,090	9,740	10,606,610	358,434	21,681,195	802,199
May	19,780	3,972	1,652,740	57,718	5,046,265	207,101
June	142,224	14,112	7,997,202	279,913	19,200,828	829,662
July	26,252	4,465	5,133,924	179,692	15,647,381	616,712
August	1,193,510	87,483	4,728,614	158,029	10,651,519	437,262
September	224,705	21,182	8,111,195	283,960	15,664,350	609,641
October	74,784	13,675	5,826,607	203,934	13,086,946	481,057
November	630,654	37,515	7,971,737	271,880	13,508,381	490,882
December	142,323	29,089	6,520,578	225,824	15,265,485	599,447
Total	3,626,507	310,925	70,390,140	2,436,469	175,618,043	6,875,151

Exports of crude and refined petroleum from Texas, by customs districts, in calendar year 1909, in gallons.

Customs district.	Crude, including all natural oils.		Naphthas		Illuminating.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Corpus Christi	7,700	$232	11,326	$1,330	6,310	$568
Brazos de Santiago					9,299	1,202
Galveston	156	9	6,100	1,105	13,510	1,437
Sabine	37,044,415	1,030,344	3,695,780	253,701	60,584,865	2,808,127
Paso del Norte	6,440	235	19,850	2,749	63,720	6,466
Saluria	19,627	817	31,106	4,539	81,192	14,896
Total	37,078,338	1,031,637	3,764,162	263,424	60,758,896	2,832,696

Customs district.	Lubricating and heavy parafin.		Residuum, etc.		Total.	
	Quantity.	Value	Quantity.	Value.	Quantity.	Value.
Corpus Christi	159,745	$25,239	113,745	$4,384	298,826	$31,753
Brazos de Santiago	181	78			9,480	1,280
Galveston	511,450	74,085			531,216	76,636
Sabine	2,849,277	187,817	70,276,395	2,432,085	174,450,732	6,712,074
Paso del Norte	48,464	12,917			138,474	22,367
Saluria	57,390	10,789			189,315	31,041
Total	3,626,507	310,925	70,390,140	2,436,469	175,618,043	6,875,151

LOUISIANA.

PRODUCTION.

The following table shows the production of petroleum in Louisiana in 1908 and 1909, by districts and months:

Production of petroleum in Louisiana in 1908 and 1909, by districts and months, in barrels.

1908.

Month.	Jennings.	Welsh.	Anse la Butte.	Caddo.	Total.
January	567,652	3,572	7,675	12,247	591,146
February	440,355	2,792	8,185	15,850	467,182
March	503,182	3,004	12,133	32,446	550,765
April	571,417	2,872	21,894	31,065	627,248
May	589,673	2,428	12,059	20,970	625,130
June	458,076	2,868	9,128	6,434	476,506
July	472,601	3,127	7,035	16,664	499,427
August	345,257	3,049	18,385	48,467	415,158
September	344,396	2,131	17,238	47,774	411,539
October	295,759	1,957	8,216	120,381	426,313
November	260,739	1,877	16,361	75,475	354,452
December	262,470	1,878	7,496	72,164	344,008
Total	5,111,577	31,555	145,805	499,937	5,788,874

1909.

Month.	Jennings.	Welsh.	Anse la Butte.	Caddo.	Total.
January	231,310	2,374	4,977	63,068	301,729
February	201,730	2,514	3,425	57,765	265,434
March	205,010	2,593	2,459	78,037	288,099
April	152,156	2,186	765	72,603	227,710
May	160,999	2,632	983	82,976	247,590
June	139,821	2,976	301	93,936	237,034
July	143,541	1,661	12,673	87,283	245,158
August	148,493	1,110	2,947	96,931	249,481
September	130,907	2,139	838	84,124	218,008
October	144,111	1,946	865	82,695	229,617
November	145,602	2,248	2,253	115,034	265,137
December	162,934	1,790	5,444	114,366	284,534
Total	1,966,614	26,169	37,930	1,028,818	3,059,531

Production and value of petroleum in Louisiana in 1908 and 1909, by districts, in barrels.

District.	1908.			1909.		
	Quantity.	Value.	Price per barrel.	Quantity.	Value.	Price per barrel.
Jennings	5,111,577	$3,178,222	$0.622	1,966,614	$1,421,806	$0.723
Welsh	31,555	23,666	.75	26,169	19,882	.760
Anse la Butte	145,805	87,483	.60	37,930	31,680	.835
Caddo	499,937	214,048	.428	1,028,818	549,081	.533
Total	5,778,874	3,503,419	.605	3,059,531	2,022,449	.661

Production of petroleum in Louisiana, 1902–1909, by districts, in barrels.

Year.	Jennings.	Welsh.	Anse la Butte.	Caddo.	Total.
1902	548,617	....	....	....	548,617
1903	892,609	25,162	....	....	917,771
1904	2,923,066	35,892	....	....	2,958,958
1905	8,891,416	10,000	9,000	....	8,910,416
1906	9,025,174	23,996	25,000	3,358	9,077,528
1907	4,842,520	47,316	60,385	50,000	5,000,221
1908	5,111,577	31,555	145,805	499,937	5,788,874
1909	1,966,614	26,169	37,930	1,028,818	3,059,531

PRICES.

In the following table are given the prices paid for petroleum at wells in Louisiana in the years 1905 to 1909, inclusive:

Average monthly price of petroleum per barrel at wells in the Jennings and Caddo districts, 1905–1909.

Month.	Jennings.					Caddo.		
	1905.	1906.	1907.	1908.	1909.	1907.	1908.	1909.
January	$0.15–0.20	$0.234–0.25	$0.62 –0.67	$0.699–0.75	$0.60–0.70	$0.63–0.66	$0.725	$0.40
February	.15– .20	.241– .25	.66 – .75	.66 – .725	.60– .67	.66– .69	.735	.40
March	.15– .22	.25 – .276	.69 – .80	.67 – .792	.63– .72	.69– .72	.70	.40
April	.12– .22	.257– .31	.72 – .86	.55 – .725	.72– .76	.72– .75	.675	.50–.52
May	.12– .22	.30 – .33	.75 – .925	.52 – .725	.70– .75	.75	.635	.50–.55
June	.12– .20	.34 – .35	.75 – .97	.45 – .725	.70– .75	.75– .78	.635	.55–.57
July	.12– .20	.347– .38	.78 –1.05	.43 – .729	.70– .75	.78– .83	$0.35 –.465	.55–.60
August	.16– .20	.353– .43	.83 –1.08	.45 – .564	.75– .86	.83– .85	.30 –.35	.55–.60
September	.18– .20	.361– .48	.85 – .943	.45 – .57	.75– .86	.85	.315–.35	.60
October	.18– .23	.403– .55	.79 – .871	.55 – .577	.75– .86	.79– .85	.31 –.40	.60
November	.20– .25	.448– .60	.74 – .921	.55 – .604	.75– .775	.74– .79	.37 –.40	.60
December	.20– .27	.615– .65	.656– .80	.55 – .693	.75– .775	.74	.37 –.40	.60
Average	.179	.391	.813	.618	.723	.777	.428	.533

WELL RECORD.

In the following tables are given the well records for Louisiana for the years 1906 to 1909, inclusive:

Number of wells completed in Louisiana, 1906–1909, by districts.

District.	Completed.				Dry.				Oil.			
	1906.	1907.	1908.	1909.	1906.	1907.	1908.	1909.	1906.	1907.	1908.	1909.
Jennings	71	76	142	51	23	23	38	23	48	53	104	28
Welsh	2	1	......	2	......	......	......	1	2	1	......	1
Anse la Butte	10	4	16	9	5	2	9	4	5	2	7	5
Caddo	2	23	58	121	1	*a* 15	*b* 15	*c* 52	1	8	43	69
Total	85	104	216	183	29	40	62	80	56	64	154	103

[a] 11 gas wells. [b] 6 gas wells. [c] 19 gas wells.

Number of wells completed in Louisiana, 1906–1909, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1906	3	1	3	6	4	16	8	5	8	9	5	4	72
1907	10	3	9	6	3	11	6	7	11	15	10	13	104
1908	11	26	18	25	24	13	9	23	18	20	14	15	216
1909	20	13	19	17	20	15	27	11	15	6	10	10	183

Number of dry holes drilled in Louisiana, 1906–1909, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov	Dec.	Total.
1906	2	......	......	3	4	6	3	......	2	......	1	2	23
1907	5	3	6	4	1	4	......	1	2	7	1	6	40
1908	4	10	5	4	8	3	1	9	3	6	6	3	62
1909	6	8	6	9	7	6	15	2	10	2	4	5	80

Total and average initial daily production of new wells in Louisiana, 1906–1909, by districts, in barrels.

District.	Total initial production.				Average initial production per well.			
	1906.	1907.	1908.	1909.	1906.	1907.	1908.	1909.
Jennings	12,550	43,270	84,620	11,745	261.5	816.4	813.6	419.0
Welsh	50	75	....	....	25.0	75.0	....	....
Anse la Butte	....	3,040	5,200	955	....	1,520.0	742.8	191.0
Caddo	....	975	14,355	8,750	....	121.9	333.8	127.0
Total	12,600	47,360	104,175	21,450	252.0	740.0	676.4	210.3

Total initial daily production of new wells in Louisiana, 1906–1909, by months, in barrels.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1906	....	....	....	....	....	....	50	....	2,150	7,750	1,900	750	12,600
1907	1,400	....	840	300	150	4,270	1,505	8,340	11,175	2,580	9,450	7,350	47,360
1908	2,010	10,160	19,330	15,255	21,945	2,165	3,390	3,770	10,400	8,195	1,990	5,565	104,175
1909	3,900	865	2,260	4,730	1,250	1,560	1,720	570	640	160	2,625	1,170	21,450

The following table gives a statement of shipments of petroleum from stations on the line of the Louisiana Western Railroad and of the Kansas City Southern Railway in Louisiana during the year 1909, by months:

Rail shipments of petroleum from stations on the lines of the Louisiana Western Railroad and Kansas City Southern Railway in Louisiana in 1909.

Month.	Anse la Butte.	Caddo oil.			Jennings oil.				Total.
		Lewis and Vivian.	Mooringsport.	Oil City.	Egan.	Jennings.	Lake Charles.	Mermentau.	
January	4,308	....	10,559	51,318	19,007	82,234	8,140	4,792	180,358
February	3,425	....	6,649	70,387	3,688	78,361	3,604	2,499	168,613
March	1,857	....	10,202	64,429	11,552	28,065	3,456	11,883	131,444
April	464	....	3,658	69,885	10,703	105,971	4,009	6,768	201,458
May	619	....	....	40,498	10,376	13,382	3,488	25,099	193,762
June	....	7,004	18,352	61,970	14,147	11,550	3,592	47,146	[a] 164,261
July	12,523	4,981	35,070	52,269	21,304	35,087	3,457	72,794	237,485
August	1,702	1,666	18,259	52,269	13,196	26,022	3,185	63,632	179,931
September	465	....	23,605	40,620	19,356	25,540	4,108	58,442	172,136
October	310	5,478	41,922	44,122	22,355	53,153	3,708	42,556	213,604
November	1,238	14,026	15,733	32,896	12,850	52,865	3,132	47,678	180,418
December	4,174	6,177	11,380	40,447	11,720	40,460	2,202	27,550	144,110
Total	31,085	39,332	195,389	621,110	170,254	552,690	46,081	410,839	2,067,580

[a] Includes a small shipment from Welsh.

NOTE.—These are the official figures, calculation being made on the basis of 310.8 pounds of crude petroleum to a barrel of 42 gallons.

CALIFORNIA OIL FIELD.

PRODUCTION.

California now stands first in production of petroleum, the increase in 1909 being more than 8,500,000 barrels. Developments which began in 1908 continued with increasing rapidity in 1909, many sections producing wells of large capacity.

One of the important events of the year 1909, which created much excitement, was the drilling, in September, of the Silver Tip well on section 6 in the Coalinga field. This was said to be at that time, with the exception of the Hartnell well of the Union Oil Company, drilled at Santa Maria in 1904, the greatest well ever drilled in the State; but, of course, it has been exceeded by the Lake View gusher, in 1910. Other important developments have extended the Coalinga field to the west and south. Successful wells drilled in the Sunset, Midway, and other districts prove the forecasted great richness of the oil fields of the State. During 1909 several pipe lines were under construction to carry the increasing product. There was a satisfactory increase in price, notwithstanding the great quantity of the product.

The following table shows the production and value of petroleum in California for the years 1908 and 1909, by districts and counties:

Production and value of petroleum in California in 1908 and 1909, by districts and counties, in barrels.

	1908.			1909.		
	Quantity.	Value.	Price per barrel.	Quantity.	Value.	Price per barrel.
Coastal and southern districts:						
Los Angeles County—						
Los Angeles city	637,328	$432,075	$0.678	457,779	$316,174	$0.691
Newhall						
Puente						
Salt Lake-Sherman						
Whittier						
Orange County—						
Brea Cañon	15,551,504	8,784,038	.565	16,136,188	9,793,562	.607
Fullerton						
Ventura County—						
Santa Paula						
Santa Barbara County—						
Lompoc						
Santa Maria						
Summerland	58,103	34,835	.599	71,189	42,019	.590
San Luis Obispo County						
San Mateo County	88,741	45,795	.516	70,179	38,846	.554
Santa Clara County						
San Joaquin Valley districts:						
Fresno County—						
Coalinga	10,386,168	5,392,916	.519	14,478,181	8,273,052	.571
Kern County—						
Kern River	13,648,286	6,770,018	.496	14,453,402	7,472,935	.517
McKittrick	2,517,951	1,196,686	.475	5,098,579	2,917,278	.572
Midway	410,393	177,753	.433	2,019,952	1,011,919	.501
Sunset	1,556,263	599,386	.385	1,647,561	809,482	.491
Total	18,132,893	8,743,843	.482	23,219,494	12,211,614	.526
Grand total	44,854,737	23,433,502	.522	54,433,010	30,675,267	.564

The following table shows the production of petroleum in California, by counties, from 1900 to 1909, inclusive:

Production of petroleum in California, 1900–1909, by counties, in barrels.

Year.	Fresno.	Kern.	Los Angeles.	Orange.	Santa Barbara.	Ventura.	San Mateo.	Santa Clara.	Total.
1900	532,000	892,500	1,730,263	372,200	153,750	418,000	....	771	[b] 4,324,484
1901	780,650	4,493,455	2,188,633	724,565	135,900	463,127	....	....	8,786,330
1902	572,498	9,705,703	1,938,114	1,038,549	242,840	484,764	1,800	....	13,984,268
1903	2,138,058	18,077,900	2,087,627	1,413,782	306,066	348,295	5,137	5,607	24,382,472
1904	5,114,958	19,608,045	2,102,892	1,473,335	789,006	517,770	1,500	41,928	29,649,434
1905	10,967,015	14,487,967	3,469,433	1,429,688	2,684,837	337,970	50,563		33,427,473
1906	7,991,039	14,520,854	3,449,119	2,032,637	4,774,361	299,124	[a] 31,464		33,098,598
1907	8,871,723	15,652,156	3,477,235	2,604,982	8,708,077	357,094	[a] 77,108		39,748,375
1908	10,386,168	18,132,893	4,692,495	3,358,714	7,816,682	379,044	[a] 88,741		44,854,737
1909	14,478,181	23,219,494	16,665,156				[a] 70,179		54,433,010

[a] Includes oil produced in San Luis Obispo County.
[b] Includes 225,000 barrels unapportioned.

Production of petroleum in California in 1908 and 1909, by districts and counties, with increase or decrease, in barrels.

District.	1908.	1909.	Increase.	Decrease.
Coastal and Southern:				
Los Angeles County—				
Los Angeles City	637,328	457,779	....	179,549
Newhall				
Puente				
Salt Lake-Sherman				
Whittier				
Orange County—				
Brea Canon	15,551,504	16,136,188	584,684	....
Fullerton				
Ventura County—				
Santa Paula				
Santa Barbara County—				
Lompoc				
Santa Maria				
Summerland	58,103	71,189	13,086	....
San Luis Obispo County				
San Mateo County	88,741	70,179	....	18,562
Santa Clara County				
San Joaquin Valley:				
Fresno County—				
Coalinga	10,386,168	14,478,181	4,092,013	....
Kern County—				
Kern River	13,648,286	14,453,402	805,116	....
McKittrick	2,517,951	5,098,579	2,580,628	....
Midway	410,393	2,019,952	1,609,559	....
Sunset	1,556,263	1,647,561	91,298	....
Total	44,854,737	54,433,010	9,578,273	....

PIPE LINES.

To take care of California's great petroleum production a vast system of pipe lines has been constructed, a brief description of which may be of interest.

Four lines in operation are in the Coalinga field. The Standard Oil Company has two lines, one of 8-inch and one of 6-inch pipe, 133 miles in length, with terminals at Point Richmond on the Bay of San Francisco. The Associated Transportation Company has one 6-inch pipe line in operation, 110 miles in length, with terminal at Monterey; also a line to Salinas; and has another line of 8-inch rifled pipe in course of construction, which will be 198 miles long when completed from Coalinga to the terminal at Port Costa. The Producers' Transportation Company has just completed (March, 1910) and put in operation an 8-inch pipe line from Coalinga to Port Harford, about 100 miles in length, which makes a junction in the Devil's Den district with a line coming north from McKittrick, Midway, and Bakersfield. It is said that the pipe line from the junction to Port Harford will soon be doubled. Shipments of crude oil are also made from this field by railroad.

The Associated Pipe Line Company has an 8-inch rifled line extending from the Kern River field to Port Costa, and the Standard Oil Company has lines running from this field to Point Richmond, a line from the Midway field connecting with them. The field is also tapped by the Southern Pacific Railroad. The crude petroleum produced in the McKittrick and Sunset fields in 1909 was shipped by rail.

Three pipe lines transport petroleum from the Santa Maria oil field. The Union Oil Company has two lines, one of 6-inch and one of 8-inch pipe, from Orcutt and Lompoc to Port Harford. The Standard Oil Company has an 8-inch line to Port Harford and the Associated Transportation Company has an 8-inch line to Gaviota. Shipments are also made from this field by rail from Careaga and Orcutt.

It may be of interest in this connection to give the shipments of California oil by sea for the calendar year 1909. Practically the whole tonnage of crude oil was sent to the coast by pipe line. The quantity shipped to points on the Pacific Coast, Honolulu, and elsewhere consisted of 20,920,120 barrels of crude oil and of 1,327,475 barrels of refined oil.

WELL RECORD.

The following table gives the well record of California for the year 1909:

Well record in California, 1909, by counties.

County.	Total productive wells, Jan. 1, 1909.	Wells drilled in 1909.			Wells abandoned in 1909.	Total productive wells, Dec. 31, 1909.	Wells drilling, Dec. 31, 1909.
		Oil.	Dry.	Total.			
Fresno	474	125	10	135	5	594	38
Kern	1,564	361	33	394	16	1,909	55
Los Angeles	924	53	1	54	16	961	11
Orange	182	15	4	19	4	193	5
San Luis Obispo, San Mateo, Santa Clara	19	1	5	6	1	19	5
Santa Barbara	314	14	5	19	7	321	23
Ventura	285	9	2	11	9	285	13
Total	3,762	578	60	638	58	4,282	150

FIELD WORK IN CALIFORNIA IN 1909.

The following interesting details of field operations in the California oil regions have been contributed by Mr. Ralph Arnold, formerly of the United States Geological Survey:

The year 1909 marked the beginning of very active development in the Midway district. This was the most important item in the progress of the oil industry in California for the year. During November and December, 1908, and January, 1909, there was considerable activity in the northern end of the Midway field, and many derricks were erected and drilling was begun on several sections about the same time.

The boom may be said to have started with the completion of the Santa Fe well in sec. 6, T. 32 S., R. 23 E, which began flowing at the rate of 2,500 barrels per day, the gravity of the oil being 24° Baumé. About the same time the Mays well in sec. 30, T. 31 S., R. 23 E., began flowing 24° gravity oil at the rate of about 10,000 barrels per day; after the original gas pressure was relieved the well produced through a screen at the rate of 2,000 to 3,000 barrels per day.

Two other wells which came prominently into notice in 1909 were the gas wells of the Honolulu Oil Company in sec. 10, T. 32 S., R. 24 E., and of the Standard Oil Company in sec. 26, T. 31 S., R. 24 E., both in the Buena Vista Hills. The success of these wells stimulated development work to such an extent that derricks were erected and drilling operations begun on many of the sections in these hills not owned by the Southern Pacific Company. The stratum supplying the gas was encountered at a depth of between 1,500 and 2,000 feet, and the terrific pressure made operation hazardous. The Honolulu well was finally brought under control and the gas stratum penetrated; drilling continued to a depth of about 2,700 feet, where a commercially productive oil sand was encountered. This occurrence of gas in large quantities above the oil is somewhat similar to the occurrences in the Caddo field of Louisiana and at certain points in the Sherman field, west of Los Angeles.

In addition to the northward extension of the Midway field, proved by the bringing in of the Santa Fe and Mays gushers, there was a southward and eastward extension by development southeast of Spellacy Hill. This last development, coupled with that at the northern end of the Sunset field, practically united the two, so that the close of 1909 showed an almost uninterrupted belt of productive wells from 1 to 2 miles wide, beginning at the southern edge of the Sunset field in sec. 20, T. 11 N., R. 23 W., of the San Bernardino base and meridian, and extending for about 20 miles northwestward to sec. 14, T. 31 S., R. 22 E. of the Mount Diablo base and meridian. The generally accepted line between the Sunset district on the south and the Midway district on the north is that marking the change from the San Bernardino base and meridian to the Mount Diablo base and meridian. The Buena Vista field and the Elk Hills field are included in the Midway district, although the Elk Hills field will eventually merge into the southeastern extension of the McKittrick district.

Extensions in the Sunset field were principally toward the north and east along the eastward extension of the Thirty-fifth anticline, but a few wells on the flat east of the old Sunset area extended the proved territory nearly a mile in this direction also.

With the exception of drilling within proved lines, very little work was done in the McKittrick district. One extension, however, was recorded in the bringing in of the Nacerima well in sec. 6, T. 30 S., R. 22 E., in the hills north of McKittrick. This well extended the producing territory northeast a short distance. The product of the well is heavy oil of 12° to 14° gravity, Baumé, and the production is from 25 to 40 barrels per day. Wells drilled in this immediate vicinity in previous years were not operated because of the low price of oil at the time of their completion. With an increased demand for heavy oil, considerable territory north of McKittrick will doubtless be developed.

Desultory operations were carried on in the Devil's Den district in 1909, but little of importance was discovered. Most of the drilling was done with the intention of proving up on ground that had been classified as mineral by the United States Geological Survey, but this work was rewarded with rather questionable results.

The principal development work in the Coalinga district included the southeastern extension of the Westside field by the operations of the American Petroleum, the Nevada Petroleum, and the Valley Oil companies. A considerable number of wells was drilled during the year, but, with the exceptions mentioned, they added little to the knowledge of the proved territory.

A few wells drilled around the edges of the Kern River field added slightly to the area of proved ground in this region, but nothing new of importance was discovered.

In the coast counties considerable development work was going on during the year, but only a few discoveries of importance were recorded. Among those which might be mentioned, beginning at the Puente Hills district, the southernmost one in the State, was the discovery of oil in the Bastanchury well in the Coyote Hills at a depth of over 4,400 feet. The quality of this oil was 26° gravity, Baumé. The gas pressure leads those who study the well to believe that a good commercial venture will result from proper development in this region.

A slight westward extension of the Fullerton field was also made by wells of the Fullerton and the Orange Oil companies, both of which brought in good producers, yielding a moderately high gravity oil—about 25° Baumé.

In the Los Angeles district development was carried on largely in the western extension or Sherman field, where one or two gas wells and several producing oil wells were encountered. The drilling, however, showed that this territory was more or less "spotted."

In Ventura County a new field was developed in the Simi Valley by the Union Oil Company, which brought in a well north of the town of Simi. This well produces about 50 or 60 barrels of 24° gravity oil at a depth under 1,000 feet. The field is rather limited and will probably never add very materially to the production of the State. Considerable work was done in Ventura County, where some of the old fields were extended slightly by the bringing in of new wells along their edges. It was found in some places that sands which had been found barren at shallow depths became productive when the same beds were penetrated at greater depths. The quality of the oil in nearly all of these new extensions was of a good refining character.

No new developments were made in the Santa Maria district owing to the fact that most of the companies operating in this field were using their development funds for operations in the Midway district.

In conclusion, it might be said that no new territory was developed outside of the areas which have been for a long time considered oil land.

COLORADO.

PRODUCTION.

Some excitement was aroused in the Boulder field by the development of a gusher which, however, proved short lived. The production in this field increased slightly, as shown in the table below, but this was more than offset by the decline in the Florence field. The Rangely field received much attention during the year, but production is waiting upon transportation facilities. During the year a preliminary examination of the oil wells at De Beque was made by the United States Geological Survey, with the result of sending a Survey party to this field in 1910.

An unusually detailed report of the sales of refined oil in Colorado in 1909 has been made to the governor of the State by Claude E. Street, State inspector of oils.

In the following table is given the production of petroleum in the Florence and Boulder fields, by months, in 1908 and 1909:

Production of petroleum in the Boulder and Florence fields in 1908 and 1909, by months, in barrels.

Month.	1908.			1909.		
	Boulder.	Florence.	Total.	Boulder.	Florence.	Total.
January	8,611	21,888	30,499	9,507	23,279	32,786
February	8,392	20,407	28,799	8,037	23,081	31,118
March	9,193	22,799	31,992	7,370	21,644	29,014
April	8,492	24,702	33,194	6,986	18,497	25,483
May	7,807	28,592	36,399	7,302	17,853	25,155
June	6,937	28,041	34,978	6,689	17,688	24,377
July	7,121	29,007	36,128	5,635	18,291	23,926
August	7,644	25,128	32,772	5,513	18,099	23,612
September	4,905	26,841	31,746	12,189	16,544	28,733
October	5,316	23,305	28,621	7,319	16,595	23,914
November	5,247	22,086	27,333	5,680	16,381	22,061
December	4,509	22,683	27,192	3,482	17,110	20,592
Total	84,174	295,479	379,653	85,709	225,062	310,771

In the following table will be found the production and value of petroleum in the Boulder and Florence fields in Colorado from 1900 to 1909, inclusive:

Production and value of petroleum in Colorado, 1900–1909, by districts, in barrels.

Year.	Boulder.		Florence.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1900	....	....	317,385	$323,434	317,385	$323,434
1901	....	....	460,520	461,031	460,520	461,031
1902	11,800	....	385,101	....	396,901	484,683
1903	36,722	....	447,203	....	483,925	431,723
1904	18,167	$20,034	483,596	558,001	501,763	578,035
1905	10,502	11,502	365,736	326,104	376,238	337,606
1906	48,952	53,847	278,630	208,828	327,582	262,675
1907	68,353	75,188	263,498	197,625	331,851	272,813
1908	84,174	124,794	295,479	221,609	379,653	346,403
1909	85,709	129,812	225,062	187,900	310,771	317,712

WELL RECORD.

The well record of Colorado in 1909 is shown in the following table:

Well record of Colorado in 1909, by districts.

District.	Total wells, Jan. 1, 1909.	Completed in 1909.			Abandoned.	Total wells, Dec. 31, 1909.
		Oil.	Dry.	Total.		
Boulder	21	5	4	9	2	24
Florence	56	9	28	37	9	56
Rangely [a]	14	17	7	24		31
	91	31	39	70	11	111

[a] None of the wells in the Rangely field was producing in 1909, there being no means of transportation.

NEW MEXICO.

During 1909 prospecting was active in the southeastern part of New Mexico in Chaves and Eddy Counties. In drilling artesian wells it had been noticed repeatedly that when the wells were drilled only a distance of 50 or 100 feet below the water-producing sand, a stratum was reached yielding enough oil to spoil the well for irrigation purposes. Natural gas of considerable pressure was also found in several localities, especially 5 miles southeast of the town of Dayton, Eddy County. This led to the formation of several oil companies, and the Hammond Oil Company, and the Giant Oil Company, both of Roswell, N. Mex., began regular drilling operations, which, shortly after the close of 1909, resulted in an oil well, at a depth of 914 feet, which at first flowed about 15 barrels of oil a day and a large quantity of fresh water from the stratum above; in April, 1910, it was pumping about the same amount. In drilling this well, after passing through 20 feet of gypseous soil, the drill penetrated 80 feet of gravel, 1 foot of hard cemented gravel, 400 feet of impure gypsum, 200 feet of "cap lime rock," 10 feet of water-bearing limestone, 23 feet of dry limestone, and then oil in limestone, thickness not determined. Other wells are being drilled in the same neighborhood.

Near Alamogordo, in Otero County, signs of oil were noticed in an artesian well soon after the close of 1909 and led to much speculation in surrounding lands, but to no oil development.

Analyses of the Dayton petroleum, made by the United States Geological Survey, are as follows:

Analyses of petroleum from near Dayton, Eddy County, N. Mex.

	Oil from 12 miles south of Artesia.	Oil from Hammond well, collected by—		
		A. F. Lucas.	U. S. Geol. Survey.	Hammond Oil Co.
Specific gravity of crude	0.8951	0.9186	0.9009	0.9168
Baumé gravity	26.4	22.4	23.7	22.7
Color	Black.	Black.	Black.	Black.
Odor	Sulphur.	Sulphur.	Sulphur.	Sulphur.
Begins to boil, ° C	217	137	142	188
Gasoline (to 150° C.), per cent	None.	Trace.	1.0	None.
Kerosene (150° to 300° C.), per cent	30.0	28.5	31.0	28.0
Specific gravity	.8395	.8564	.8417	.8541
Residuum, per cent	68.9	68.4	68.1	72.0
Specific gravity	.9241	.9444	.9390	.9396
Paraffin wax, per cent	None.	None.	None.	None.
Asphalt, per cent	.56	....	3.91	3.65
Water	None.	None.	Trace.	None.
Unsaturated hydrocarbons in crude oil, per cent	....	20.0	25.6	28.4

These analyses show the composition of the oils to be in general similar to those of Reeves County in Texas, the analyses of which are given at the end of this report.

WYOMING.

Considerably more development work was carried on in the Wyoming oil fields in 1909 than in any previous year. The greatest drawback to the petroleum industry of this State is the inability to get the oil to market owing to lack of transportation facilities. In the Byron field, Bighorn County, are eight wells from which oil was produced in 1909, a portion of which was shipped to the refinery at Cowley, the remainder being used for field purposes. A quantity of petroleum from wells near Douglas, Converse County, was used locally. Some petroleum from wells in Crook County in 1909 was transported by rail and used for lubricating purposes. There was much activity in the Fremont County oil field in 1909, where about 50 productive wells have been discovered, but owing to lack of transportation little oil has been produced. Five wells were drilling in this field at the close of 1909. A small quantity of petroleum from this field was shipped by rail from Wyopo and was used by the Wyoming and Northwestern Railway; some of the oil was used locally. No petroleum was transported from the Salt Creek field, Natrona County, in 1909, although considerable work was done in this field and several new wells were completed in 1909, all of which were productive; but the distance from the nearest railroad, 50 miles, prohibits production. The oil at Newcastle, Weston County, is a very fine lubricant. The crude petroleum produced in the Evanston-Spring Valley oil field in 1909 was delivered for refining purposes to the Utah Oil Refining Company and the Pittsburg-Salt Lake Oil Company. There were no developments in Johnson County in 1909; one well which was drilled in 1905 and will produce a fine grade of lubricating oil was not operated in 1909 on account of lack of transportation.

Production of petroleum in Wyoming, 1900–1909, in barrels.

Year.	Quantity.	Year.	Quantity.
1900	5,450	1905	8,454
1901	5,400	1906	[a] 7,000
1902	6,253	1907	[b] 9,339
1903	8,960	1908	[b] 17,775
1904	11,542	1909	[b] 22,137

a Estimated. b Includes the production of Utah.

UTAH.

It is difficult to obtain accurate statistics concerning the quantity of petroleum produced in Utah, as no account of the production is kept. Petroleum has been discovered in four counties. A small quantity produced in 1909 near Dragon, Uinta County, was used for lubricating and fuel purposes. In Sanpete County 2 wells have been drilled and oil discovered, but not in commercial quantity. In San Juan County 17 shallow wells, ranging from 120 to 680 feet in depth, have been drilled which have a showing of oil. A small quantity produced in 1909 was consumed in the field. In the Virgin field, Washington County, petroleum is produced from a few wells 500 to 700 feet in depth. At the close of 1909 a well was being drilled in this field which had reached a depth of 2,200 feet, with a very fine-grained sand. The petroleum produced in the Virgin field in 1909 was used in the operation of engines in the field, none being shipped. Several attempts were made to find oil in Juab County in 1909, but were unsuccessful.

MISSOURI.

Prospecting in Missouri was unusually active in 1909, but the statistical position was unchanged and was unimportant.

Production of petroleum in Missouri, 1900–1909, in barrels.

Year.	Quantity.	Year.	Quantity.
1900	[a] 1,602	1905	[a] 3,100
1901	[b] 2,335	1906	[a] 3,500
1902	[a] 757	1907	[a] 4,000
1903	[a] 3,000	1908	[a] 15,246
1904	[a] 2,572	1909	[a] 5,750

a Includes the production of Michigan.
b Includes the production of Michigan and a small production in Oklahoma.

EXPORTS.

TERRITORIAL SHIPMENTS.

Alaska.—In the following table are given the shipments of petroleum products to Alaska from 1905 to 1909, inclusive:

Shipments of petroleum products to Alaska from other parts of the United States, 1905–1909, in gallons.

Year.	Crude.		Naphtha.		Illuminating.		Lubricating.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1905	2,715,386	$91,068	713,496	$109,921	627,391	$113,921	83,319	$31,660
1906	2,688,100	38,409	580,978	100,694	568,033	109,964	83,992	32,854
1907	9,104,300	143,506	636,881	119,345	510,145	99,342	100,145	37,929
1908	11,891,375	176,483	939,424	147,104	566,598	102,567	94,542	36,423
1909	14,034,900	334,258	746,930	118,810	531,727	98,786	85,687	35,882

Hawaiian Islands, Philippine Islands, and Porto Rico.—In the following table are given the shipments of petroleum products to the Hawaiian Islands, Philippine Islands, and Porto Rico from 1905 to 1909, inclusive:

Shipments of petroleum products to Hawaii, the Philippines, and Porto Rico, 1905–1909, in gallons.

Year.	Crude.		Naphtha.		Illuminating.		Lubricating.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
HAWAII.								
1905	31,904,340	$1,112,939	320,703	$39,069	892,094	$142,313	195,850	$61,605
1906	38,883,100	871,830	550,975	71,954	1,225,864	199,443	241,567	76,134
1907	38,916,400	581,905	484,435	73,405	1,441,637	230,968	355,451	104,930
1908	47,719,900	802,325	648,310	91,851	1,143,591	179,507	358,262	140,157
1909	43,461,493	845,805	804,169	127,076	1,401,381	232,340	367,831	121,282
PHILIPPINES.								
1905	....	....	60,000	9,096	3,847,810	380,322	236,123	44,573
1906	7,360	442	40,450	6,482	4,412,398	398,706	195,006	39,887
1907	....	....	79,560	12,930	8,218,400	842,111	181,504	32,598
1908	4,594	322	140,550	21,775	9,234,263	957,284	257,800	61,571
1909	15,489	1,014	184,390	23,428	5,995,090	558,642	362,068	81,278
PORTO RICO.								
1905	....	....	49,493	7,697	1,365,446	140,569	93,513	20,253
1906	16,585	1,224	79,841	17,766	1,315,589	151,013	196,732	41,777
1907	....	....	219,691	38,003	1,700,838	176,808	223,389	53,599
1908	24,937	2,100	285,188	45,479	1,623,477	189,021	264,012	65,776
1909	5,089	340	495,367	93,649	1,931,676	216,316	218,829	78,963

FOREIGN EXPORTS.

The tables following are the official statement by the Bureau of Statistics of the Department of Commerce and Labor of the quantity and value of petroleum and its products (mineral oils) exported from ports and districts in the United States for the years ending December 31, 1908 and 1909.

Exports of mineral oils from the United States in 1908 and 1909, by kind and port, in gallons.

Kind and port.	1908		1909	
	Quantity.	Value.	Quantity.	Value.
CRUDE.				
New York	36,547,123	$2,301,040	35,370,334	$2,166,199
Philadelphia	25,231,014	1,743,547	10,907,686	802,100
Galveston	51,035	2,317	156	9
Other districts	87,360,845	2,472,945	124,059,597	3,059,280
Total	149,190,017	6,519,849	170,337,773	6,027,588
NAPHTHA.				
Baltimore	32,425	8,481	18,434	2,767
Boston and Charlestown	47,516	6,685	43,005	5,830
New York	17,750,261	2,254,983	37,712,825	3,184,669
Philadelphia	16,897,562	1,422,867	15,985,705	1,349,355
Galveston	250	37	6,100	1,105
Other districts	9,159,030	849,498	14,992,606	1,256,268
Total	43,887,044	4,542,551	68,758,675	5,799,994
ILLUMINATING.				
Baltimore	11,271,567	658,941	10,695,961	642,472
Boston and Charlestown	196,722	24,386	175,405	21,267
New York	646,872,094	48,449,555	616,183,294	44,288,463
Philadelphia	339,507,776	20,465,249	302,795,972	17,360,414
Galveston	50,106	5,375	13,510	1,437
Other districts	131,106,568	6,384,750	116,536,930	5,500,353
Total	1,129,004,833	75,988,256	1,046,401,072	67,814,406
LUBRICATING AND PARAFFIN.				
Baltimore	4,440,400	682,023	5,100,686	746,498
Boston and Charlestown	225,499	41,583	217,863	40,788
New York	94,612,963	12,829,262	99,517,999	13,261,932
Philadelphia	43,698,080	4,634,629	48,475,280	4,682,042
Galveston	217,939	46,528	511,450	74,085
Other districts	4,574,143	737,411	7,816,331	1,210,762
Total	147,769,024	18,971,436	161,639,609	20,016,107
RESIDUUM.				
Boston and Charlestown	644,832	22,202	424,967	13,997
New York	1,682,976	82,128	2,965,593	120,510
Philadelphia	34,663,273	1,224,596	34,512,290	1,166,191
Other districts	40,560,602	1,464,437	84,063,399	2,879,797
Total	77,551,683	2,793,363	121,966,249	4,180,495
Grand total	1,547,402,601	108,815,455	1,569,103,378	103,838,590

RECAPITULATION BY KINDS, IN GALLONS.

Crude	149,190,017	$6,519,849	170,337,773	$6,027,588
Naphtha	43,887,044	4,542,551	68,758,675	5,799,994
Illuminating	1,129,004,833	75,988,256	1,046,401,072	67,814,406
Lubricating and paraffin	147,769,024	18,971,436	161,639,609	20,016,107
Residuum	77,551,683	2,793,363	121,966,249	4,180,495
Total	1,547,402,601	108,815,455	1,569,103,378	103,838,590

RECAPITULATION BY PORTS, IN GALLONS.

Baltimore	15,744,392	$1,349,445	15,815,081	$1,391,737
Boston and Charlestown	1,114,569	94,856	861,240	81,882
New York	797,465,417	65,916,968	791,750,045	63,021,773
Philadelphia	459,997,705	29,490,888	412,676,933	25,360,102
Galveston	319,330	54,257	531,216	76,636
Other districts	272,761,188	11,909,041	347,468,863	13,906,460
Grand total	1,547,402,601	108,815,455	1,569,103,378	103,838,590

Exports of mineral oils from the United States in 1908 and 1909, by months, in gallons.

Month.	1908		1909	
	Quantity.	Value.	Quantity.	Value.
January	107,322,016	$7,830,355	125,047,993	$8,193,723
February	116,140,370	8,008,708	91,719,956	6,558,096
March	122,363,300	9,416,813	139,433,675	9,596,123
April	118,900,738	9,207,013	141,999,696	9,444,228
May	140,940,632	9,906,110	117,477,777	8,420,828
June	135,950,594	9,805,473	140,207,288	9,145,656
July	150,681,620	10,347,268	133,750,661	8,793,155
August	137,039,268	9,272,545	127,384,137	8,023,502
September	144,481,414	9,860,970	156,441,521	9,921,758
October	143,221,807	9,379,026	133,499,602	8,669,062
November	104,530,658	7,375,916	139,016,885	8,879,468
December	125,830,184	8,405,258	123,124,187	8,192,991
Total	1,547,402,601	108,815,455	1,569,103,378	103,838,590

The following table exhibits the total production of petroleum from 1900 to 1909, in barrels and in gallons, also the separate derivatives exported and their value, together with their sum and value:

Quantity of petroleum produced in, and quantities and values of petroleum products exported from, the United States during each of the calendar years from 1900 to 1909, inclusive, in gallons.

Year.	Production.		Exports.			
	Barrels of 42 gallons.	Gallons.	Mineral, crude (including all natural oils, without regard to gravity).		Mineral, refined or manufactured. Naphtha, benzine, gasoline, etc.	
			Quantity.	*Value.*	*Quantity.*	*Value.*
1900	63,620,529	2,672,062,218	138,161,173	$7,340,749	18,570,488	$1,681,201
1901	69,389,194	2,914,346,148	127,008,002	6,037,544	21,684,734	1,741,547
1902	88,766,916	3,728,210,472	145,233,723	6,331,011	19,682,637	1,392,771
1903	100,461,337	4,219,376,154	126,511,687	6,782,136	12,973,153	1,518,541
1904	117,080,960	4,917,400,320	111,176,476	6,350,682	24,989,422	2,321,714
1905	134,717,580	5,658,138,360	126,185,187	6,085,592	28,419,930	2,214,609
1906	126,493,936	5,312,745,312	148,045,315	7,731,226	27,544,939	2,488,401
1907	166,095,335	6,976,004,070	126,306,549	6,333,715	34,625,525	3,676,206
1908	178,527,355	7,498,148,910	149,190,017	6,519,849	43,887,044	4,542,551
1909	182,134,274	7,649,639,508	170,337,773	6,027,588	68,758,675	5,799,994

Year.	Exports. Mineral, refined or manufactured.				Exports.			
	Illuminating.		Lubricating (heavy paraffin, etc.).		Residuum (tar, pitch, and all other, from which the light bodies have been distilled).		Total exports.	
	Quantity.	*Value.*	*Quantity.*	*Value.*	*Quantity.*	*Value.*	*Quantity.*	*Value.*
1900	739,163,464	$54,692,872	71,211,353	$9,933,548	19,749,996	$845,337	986,856,474	$74,493,707
1901	827,479,493	53,490,713	75,305,938	10,260,125	27,596,352	1,254,983	1,079,074,519	72,784,912
1902	778,800,978	49,079,055	82,200,503	10,872,154	38,315,760	922,152	1,064,233,601	68,597,143
1903	691,837,234	51,355,668	95,621,941	12,690,065	9,753,240	282,129	936,697,255	72,628,539
1904	761,358,155	58,384,273	89,688,123	12,393,382	34,904,100	1,174,156	1,022,116,276	80,624,207
1905	881,450,388	54,900,649	113,730,205	14,312,383	70,727,877	2,127,696	1,220,513,587	79,640,929
1906	878,274,104	54,858,312	151,268,522	18,689,622	64,644,765	1,971,305	1,269,777,645	85,738,866
1907	905,924,296	59,635,208	152,028,855	19,210,353	75,774,754	2,527,582	1,294,659,979	91,383,064
1908	1,129,004,833	75,988,256	147,769,024	18,971,436	77,551,683	2,793,363	1,547,402,601	108,815,455
1909	1,046,401,072	67,814,406	161,639,609	20,016,107	121,966,249	4,180,495	1,569,103,378	103,838,590

Exports of domestic petroleum from Pacific ports during the calendar years 1908 and 1909 were as follows.

Exports of petroleum from Pacific ports in 1908 and 1909, in gallons.

Customs district.	1908		1909	
	Quantity.	Value.	Quantity.	Value.
From—				
Los Angeles	20,720,433	$446,386	18,170,000	$346,300
Puget Sound	3,814,301	73,017	3,488,034	72,098
San Diego			27,580	812
San Francisco	64,099,635	1,018,802	83,934,734	1,495,508
Total	88,634,369	1,538,205	105,620,348	1,914,718
To—				
Alaska	11,891,375	176,483	14,034,900	334,258
Canada	3,492,151	59,765	3,828,934	79,506
Chile	4,578,000	65,400	17,809,500	268,535
Guatamala	2,793,000	66,500	1,050,000	15,000
Hawaii	47,719,900	802,325	43,461,493	845,805
Japan	10,934,433	262,486		
Mexico			27,580	812
Panama	7,224,000	105,200	23,882,500	339,150
Peru	1,100	33	1,516,349	30,690
Salvador	410	13	1,650	50
Other			7,442	912
Total	88,634,369	1,538,205	105,620,348	1,914,718

FOREIGN MARKETS.

In the following table is given a statement showing the foreign markets for our oil in the four fiscal years ending June 30, 1909:

Exports of petroleum in its various forms from the United States for the fiscal years 1906–1909, by countries and kinds, in gallons.

Country and kind.	Year ending June 30—			
	1906	1907	1908	1909
CRUDE.				
Europe:				
Belgium		897,370	52	201,107
France	55,103,511	47,777,692	40,555,219	33,168,985
Germany	6,543,989	4,936,082	6,485,413	
Spain	13,490,077	8,603,703	9,526,563	10,038,730
United Kingdom	19,131,352	12,660,797	8,934,223	24,590,204
Other Europe	1,250	150	2,470	511
	94,270,179	74,875,794	65,503,940	67,999,537
North America:				
Mexico	14,366,495	19,992,434	17,523,440	27,554,581
Cuba	6,266,626	5,385,898	5,040,720	5,493,314
Dominion of Canada	23,882,943	22,571,811	28,577,508	35,366,004
Panama	27,963	3,398,100	5,562,745	13,250,620
Other North America	45,192	5,305,767	906,405	1,899,204
	44,561,256	53,255,910	57,610,818	83,563,723
South America	850,180	23,200	3,365,728	10,182,832
Japan		1,075	8,742,789	8,102,423
All other countries	7,000	20,833	300	6,794
Total crude	139,688,615	128,175,737	135,223,575	169,855,309
REFINED.				
Naphtha.				
Europe:				
France	8,417,101	5,623,747	10,485,796	23,553,067
Germany	3,782,176	492,865	2,074	750,000
Sweden	259,648	336,045	1,267,611	378,558
United Kingdom	12,888,828	7,222,433	6,843,892	16,148,285
Other Europe	1,884,941	3,016,619	2,701,661	4,623,663
	27,232,694	16,691,709	21,301,034	45,453,573

Exports of petroleum in its various forms from the United States for the fiscal years 1906–1909, by countries and kinds, in gallons—Continued.

Country and kind.	Year ending June 30—			
	1906	1907	1908	1909
REFINED—continued.				
Naphtha—Continued.				
North America	1,980,814	4,770,891	7,994,179	8,704,588
West Indies	80,338	131,825	132,171	310,241
South America	1,095,499	1,934,204	2,499,971	3,690,656
Asia and Oceania	1,664,071	2,214,135	3,588,315	4,602,975
Africa	703,278	614,290	726,700	1,069,234
	5,524,000	9,665,345	14,941,336	18,377,694
Total naphtha	32,756,694	26,357,054	36,242,370	63,831,267
Illuminating.				
Europe:				
Belgium	43,478,987	47,942,197	48,597,412	54,429,995
Denmark	18,120,251	16,123,410	17,873,509	20,985,608
France	22,739,414	32,632,548	52,752,810	64,534,115
Germany	110,336,514	120,183,398	151,802,286	131,299,633
Italy	28,979,309	22,627,583	22,926,445	23,355,053
Netherlands	123,208,276	113,779,776	126,335,611	134,656,827
Sweden and Norway	25,626,562	29,799,154	37,738,705	43,186,026
United Kingdom	190,383,239	182,328,955	206,875,262	223,313,293
Portugal	6,021,243	5,265,000	7,759,171	5,999,563
Other Europe	3,569,867	1,395,847	4,002,069	3,182,583
	572,463,662	572,077,868	676,663,280	704,942,696
North America:				
British North America	11,263,304	10,088,253	6,196,631	13,824,783
Central America	2,014,071	2,014,242	2,424,129	2,317,303
Mexico	2,095,939	2,495,070	764,067	511,276
West Indies—				
British	2,679,322	2,878,322	2,777,266	2,859,903
Other	2,901,690	3,264,340	2,885,350	2,143,867
Other North America	573,702	512,331	653,375	683,574
	21,528,028	21,252,558	15,700,818	22,340,706
South America:				
Argentina	14,430,159	14,900,929	18,532,187	16,384,837
Brazil	24,198,146	24,528,640	24,359,423	27,999,69[illegible]
Chile	7,263,136	5,842,470	6,250,448	8,264,431
Uruguay	4,286,600	4,875,966	5,158,182	5,154,92[illegible]
Venezuela	1,236,512	1,422,441	1,207,665	1,372,07[illegible]
Other South America	3,520,193	3,510,906	3,557,761	3,503,33[illegible]
	54,934,746	55,081,352	59,065,666	62,679,29[illegible]
Asia:				
Chinese Empire	54,376,377	77,913,487	103,737,770	87,006,46[illegible]
Hongkong	5,561,590	12,048,815	11,107,670	10,370,46[illegible]
East Indies—				
British	38,204,743	37,837,841	39,173,434	42,949,02[illegible]
Dutch	12,039,360	13,475,350	11,786,410	16,140,19[illegible]
Other East Indies	....	2,441,190	5,331,150	8,757,55[illegible]
Japan	42,787,890	43,810,870	60,540,424	67,707,65[illegible]
Other Asia	11,923,490	8,775,675	7,973,490	5,610,45[illegible]
	164,893,450	196,303,228	239,650,348	238,541,80[illegible]
Oceania:				
British Australasia	20,618,140	21,621,640	22,129,092	26,776,43[illegible]
Philippine Islands	1,641,178	6,141,490	10,097,393	8,997,61[illegible]
Other Oceania	1,370	4,410	1,285	1,07[illegible]
	22,260,688	27,767,540	32,227,770	35,775,11[illegible]
British Africa	13,477,323	9,976,024	10,966,114	8,484,28[illegible]
Other Africa	14,803,313	12,070,862	7,451,905	7,778,56[illegible]
	....	22,046,886	18,418,019	16,262,84[illegible]
Total illuminating	864,361,210	894,529,432	1,041,725,901	1,080,542,45[illegible]

Exports of petroleum in its various forms from the United States for the fiscal years 1906–1909, by countries and kinds, in gallons—Continued.

Country and kind.	Year ending June 30— 1906	1907	1908	1909
REFINED—continued.				
Lubricating.				
Europe:				
Belgium	12,719,017	10,582,303	9,706,311	9,853,648
France	19,007,626	15,241,696	19,943,853	18,581,934
Germany	19,229,818	19,591,795	22,158,084	19,708,146
Italy	4,974,497	6,139,766	5,845,997	7,656,884
Netherlands	9,485,260	8,808,058	9,650,719	8,372,364
United Kingdom	46,245,278	42,141,248	50,427,085	42,000,598
Other Europe	5,736,974	5,648,556	6,936,297	6,868,299
	117,398,470	108,153,422	124,668,346	113,041,873
North America	3,244,991	4,344,831	4,287,590	4,537,812
West Indies	941,191	1,753,262	1,240,239	1,278,500
South America	4,840,251	5,402,478	6,057,608	6,742,209
Asia and Oceania	16,622,725	14,340,665	20,203,987	15,583,310
Africa	3,063,074	2,145,568	3,306,130	3,070,567
	28,712,232	27,986,804	35,095,554	31,212,398
Total lubricating	146,110,702	136,140,226	159,763,900	144,254,271
Residuum (barrels).				
Europe	1,688,741	63,650,768	65,979,758	92,070,389
North America	95,451	1,323,710	4,467,937	10,962,529
All other countries	2,280	253,531	134,127	89,330
Total residuum	1,786,472	65,228,009	70,581,822	103,188,033

PRICES.

In the following tables the prices per gallon of refined oils of 70° Abel test are given:

Weekly prices of refined petroleum in the United States in 1909, at New York, in cents per gallon.

Week ending—	Refined oil. New York. Bulk.	Cases.	Barrels.	Week ending—	Refined oil. New York. Bulk.	Cases.	Barrels.
Jan. 2	5.00	10.90	8.50	July 10	4.90	10.80	8.40
Jan. 9	5.00	10.90	8.50	July 17	4.75	10.65	8.25
Jan. 16	5.00	10.90	8.50	July 24	4.75	10.65	8.25
Jan. 23	5.00	10.90	8.50	July 31	4.75	10.65	8.25
Jan. 30	5.00	10.90	8.50	Aug. 7	4.75	10.65	8.25
Feb. 6	5.00	10.90	8.50	Aug. 15	4.75	10.65	8.25
Feb. 13	5.00	10.90	8.50	Aug. 22	4.75	10.65	8.25
Feb. 20	5.00	10.90	8.50	Aug. 29	4.75	10.65	8.25
Feb. 27	5.00	10.90	8.50	Sept. 5	4.75	10.65	8.25
Mar. 6	5.00	10.90	8.50	Sept. 12	4.75	10.65	8.25
Mar. 13	5.00	10.90	8.50	Sept. 19	4.75	10.65	8.25
Mar. 20	5.00	10.90	8.50	Sept. 26	4.75	10.65	8.25
Mar. 27	5.00	10.90	8.50	Oct. 3	4.75	10.65	8.25
Apr. 3	5.00	10.90	8.50	Oct. 10	4.75	10.65	8.25
Apr. 10	5.00	10.90	8.50	Oct. 17	4.75	10.65	8.25
Apr. 17	5.00	10.90	8.50	Oct. 24	4.65	10.55	8.15
Apr. 24	5.00	10.90	8.50	Oct. 31	4.65	10.55	8.15
May 8	5.00	10.90	8.50	Nov. 7	4.55	10.45	8.05
May 15	5.00	10.90	8.50	Nov. 14	4.55	10.45	8.05
May 22	5.00	10.90	8.50	Nov. 21	4.55	10.45	8.05
May 29	5.00	10.90	8.50	Nov. 28	4.55	10.45	8.05
June 5	5.00	10.90	8.50	Dec. 5	4.55	10.45	8.05
June 12	5.00	10.90	8.50	Dec. 12	4.55	10.45	8.05
June 19	5.00	10.90	8.50	Dec. 19	4.55	10.45	8.05
June 26	4.90	10.80	8.40	Dec. 26	4.55	10.45	8.05
July 3	4.90	10.80	8.40				

Wholesale prices of refined petroleum at New York at the first of each month, 1905–1909.

Month.	1905			1906			1907			1908			1909		
	Date.	Cents per gallon.		Date.	Cents per gallon.		Date.	Cents per gallon.		Date.	Cents per gallon.		Date.	Cents per gallon.	
		In barrels.	In cases.		In barrels.	In cases.		In barrels.	In cases.		In barrels.	In cases.		In barrels.	In cases.
January	4	7.65	10.35	3	7.60	10.30	5	7.50	10.00	4	8.75	10.90	2	8.50	10.90
February	1	7.25	9.95	7	7.60	10.30	2	7.75	10.25	1	8.75	10.90	6	8.50	10.90
March	1	7.25	9.95	7	7.60	10.30	2	7.75	10.25	7	8.75	10.90	6	8.50	10.90
April	5	7.15	9.85	4	7.60	10.30	6	8.20	10.65	4	8.75	10.90	3	8.50	10.90
May	3	6.95	9.65	2	7.60	10.30	4	8.20	10.65	2	8.75	10.90	1	8.50	10.90
June	7	6.90	9.60	6	7.80	10.30	1	8.20	10.65	6	8.75	10.90	5	8.50	10.90
July	5	6.90	9.60	6	7.80	10.30	6	8.45	10.90	4	8.75	10.90	3	8.40	10.80
August	2	6.90	9.60	2	7.80	10.30	3	8.45	10.90	1	8.75	10.90	7	8.25	10.65
September	6	6.90	9.60	7	7.50	10.00	7	8.45	10.90	5	8.75	10.90	4	8.25	10.65
October	4	7.60	10.30	6	7.50	10.00	5	8.45	10.90	3	8.50	10.90	2	8.25	10.65
November	1	7.70	10.40	3	7.50	10.00	2	8.75	10.90	7	8.50	10.90	6	8.15	10.55
December	6	7.60	10.30	1	7.50	10.00	7	8.75	10.90	5	8.50	10.90	4	8.05	10.45

Monthly average prices, in cents per gallon, of petroleum exported from the United States in bulk, 1906–1909.

Month.	1906		1907		1908		1909	
	Crude.	Refined, illuminating.	Crude.	Refined, illuminating.	Crude.	Refined, illuminating.	Crude.	Refined, illuminating.
January	5.4	6.2	5.3	6.3	4.9	6.5	3.4	6.5
February	5.3	6.4	4.9	6.1	4.7	6.4	4.6	6.7
March	5.3	6.5	4.8	6.8	5.4	7.1	3.9	6.5
April	5.2	6.2	5.3	6.8	4.5	7.2	3.7	6.8
May	5.1	6.3	4.1	6.1	3.3	7.3	4.9	7.1
June	5.2	6.8	5.8	6.8	5.6	6.8	3.4	6.3
July	5.1	6.3	5.6	6.8	4.6	7.0	2.6	6.5
August	5.3	6.2	5.5	6.8	3.8	6.8	3.9	6.1
September	4.9	6.0	4.8	6.6	4.3	6.7	3.5	6.4
October	5.2	6.3	4.9	6.6	4.9	6.1	2.9	6.2
November	5.2	5.9	4.9	6.6	3.8	6.6	2.9	6.3
December	5.3	6.1	3.7	6.6	3.6	6.4	3.1	6.5

FOREIGN OIL FIELDS.

CANADA.

PRODUCTION.

The preliminary report by the Canadian statistical bureau for 1909 says:

The production of crude petroleum was as usual nearly all derived from the Ontario peninsula. Direct returns from the producers have not been obtained, but the production upon which bounty was paid, ascertained by the Trade and Commerce Department, was 14,726,433 gallons, of which 3,328 gallons were produced in New Brunswick. This is equivalent to 420,755 barrels and, at an average price of $1.33 per barrel, was valued at $559,604. The production in 1908 was 527,987 barrels, valued at $747,102, an average per barrel of $1.41½, showing a decrease of about 20 per cent in the quantity produced. The total bounty paid in 1909 was $220,896.50 as compared with $277,193.21 in 1908, and $414,157.89 in 1907.

During 1909 tests by Dr. Charles Baskerville and other competent experts were carried out in regard to utilizing the bituminous shales of New Brunswick. The results seemed to satisfy the Canadian Government that a profitable industry could be built up by distilling these shales for oil and ammonia, as has been done with the Scotch shales.

In the following table is given the total production of petroleum in Canada from 1900 to 1909, inclusive, as reported by the Geological Survey of Canada:

Production of petroleum in Canada, 1900–1909.

Year.	Quantity.	Value.	Average price per barrel.
	Barrels.[a]		
1900	913,498	$1,479,867	$1.62
1901	756,679	1,225,820	1.62
1902	530,624	951,190	1.79¼
1903	486,637	1,048,974	2.15½
1904	552,575	984,310	1.78
1905	634,095	856,028	1.35
1906	569,753	761,760	1.337
1907	788,872	1,057,088	1.34
1908	527,987	747,102	1.41½
1909	420,755	559,604	1.33

[a] Barrels of 35 imperial gallons.

In the following table, furnished by the Imperial Oil Company (Limited), is given the production of petroleum in Ontario, Canada, during the years 1900–1909, by districts:

Production of petroleum in Ontario, Canada, 1900–1909, by districts, in barrels of 35 imperial gallons.

District.	1900	1901	1902	1903	1904	1905	1906	1907	1908	1909
Bothwell	47,405	52,873	50,141	48,880	47,654	47,959	43,836	40,556	39,820	38,707
Coatsworth (Romney)								49,784	11,165	1,082
Dutton	4,791	10,588	8,867	21,483	14,217	20,976	18,597	14,698	12,268	10,052
Leamington				1,190	25,241	113,806				
Blytheswood					669		35,958	16,210	18,117	9,367
Comber					97					
Staples										
East Tilbury							115,400	344,358	170,589	115,862
Raleigh			2,462	1,161	3,274					
Moore Township					36,971	93,815	53,030	32,720	25,667	18,033
Oil Springs	99,019	76,059	60,747	56,405	75,530	78,125	68,100	55,813	61,252	60,868
Pelee Island					1,023					
Richardson Station (Chatham)						1,249	1,376	940	2,883	2,923
Thamesville					5,027	2,463	1,585	1,139	853	710
Wheatley				1,995	4,490	1,750				
Petrolia and all other districts	541,435	432,906	397,628	350,390	278,299	250,701	247,446	206,285	171,019	156,581
Total	692,650	572,416	519,845	481,504	492,492	610,844	585,328	762,503	513,633	414,185

Prices.—The average monthly prices per barrel from 1905 to 1909, inclusive, are given in the following table:

Average monthly prices per barrel for crude oil at Petrolia, 1905–1909.

Month.	1905	1906	1907	1908	1909	Month.	1905	1906	1907	1908	1909
January	$1.42	$1.38	$1.34	$1.34	$1.44	August	$1.30	$1.38	$1.38	$1.44	$1.26
February	1.37	1.38	1.35	1.34	1.44	September	1.33	1.34	1.38	1.44	1.26
March	1.37	1.38	1.37	1.34	1.44	October	1.39	1.34	1.38	1.44	1.25
April	1.33	1.40	1.38	1.44	1.44	November	1.39	1.34	1.38	1.44	1.24
May	1.31	1.40	1.38	1.44	1.36	December	1.38	1.34	1.38	1.44	1.24
June	1.30	1.40	1.38	1.44	1.33						
July	1.30	1.38	1.37	1.44	1.27	The year	1.35	1.3734	1.37	1.41½	1.33

MEXICO.

Although there was a decline in the quantity of petroleum produced in Mexico, the activity in exploratory work increased. This work was carried on by the following companies:

Petroleum-producing companies in Mexico in 1909.

	Controlled by—	Location of wells.	Remarks.
Mexican Petroleum Co	E. L. Doheny and associates, Los Angeles, Cal.	Ebano, Vera Cruz	448,000 acres.
Huasteca Oil Co	do	100 miles south of Tampico.	8-inch line building to Tampico; 3-foot railroad Casiano to Tampico.
Oil Fields of Mexico (Ltd.)	Percy Furber & Bros.	Furbero, Vera Cruz	To be piped to the mouth of the Tuxpam River, a few miles from town of Tuxpam.
Compañía de Petróleo Aguila, S. Pearson & Sons.	S. Pearson & Sons, and Mexican stockholders.	Tamijui; Dos Bocas; Potrero del Llano; Tahuijo; Valles; Tumbadero; Reyes; San Cristobal; Soledad; Concepcion; Filisola; Tuzandepe; State of Tabasco.	Product under contract to Compañía de Petróleo, Aguila (S. Pearson & Sons).
Mexican Fuel Co	Waters, Pierce Oil Co.	Topilo River, near Tampico.	
Mexico Fuel Oil Co	Chas. G. Dawes, Central Trust Co., Chicago.	Tamesi River, above Tampico.	2 wells leased from Tamesi Asphalt and Petroleum Co.
Tamesi Asphalt and Petroleum Co.	Leased to Mexico Fuel Oil Co.	Tamesi River	
Standard Oil Co., of Mexico	English capital	"El Gallo" property, in Tuxpam district.	Drilling.
East Coast Oil Co	Southern Pacific R. R. Co., of Mexico.	Near Tuxpam and near Tamesi River.	4 wells (capped). One good well on Tamesi River, 1,600 feet deep.
Texas-Mexico Asphalt and Petroleum Co.		San Jose de las Rusias, 125 miles north of Tampico.	1,000,000 acres.
American International Fuel and Petroleum Co.		Los Esteros (Tamaulipas).	130,000 acres of land owned and 50,000 acres of leases.
Indian Territory Illuminating Oil Co.	T. N. Barnsdall	Dulce Nombre Tuliju River, Tabasco.	Wells begun in 1909; combination rigs.

A result of special interest was the development of sufficient crude oil in the wells of the Mexican Petroleum Company, Huasteca Branch, at Juan Casiano, Vera Cruz, to encourage it to build a pipe line from this oil field to Tampico. The pipe line was in course of construction at the end of the year 1909.

The Pearson interests were even more successful in developing shallow wells with unusual oil pressures in the Tamiahua region and deep wells with much promise at Potrero del Llano, Vera Cruz. Successful wells were also brought in at Concepcion, Vera Cruz, and deeper drilling gave wells of some promise in Tabasco. The Pearson interests also brought in several flowing wells at Soledad, Isthmus of Tehuantepec, Vera Cruz. This oil is of very high grade; it runs about 30° Baumé.

Much activity was shown by several companies in the neighborhood of Tampico, where several wells of very thick asphaltic oil resulted.

A well was also started in 1909 on the property called Dulce Nombre, near the Tulija River, State of Tabasco, by the Indian Territory Illuminating Oil Company, of which T. N. Barnsdall is said to be president.

A pipe line was completed between the Furbero wells and Tuxpam, but no oil was run, pending the completion of a deep-sea line from Tuxpam beach to a point where steamers could load at anchor, as the bar at the mouth of the river prevents steamers of deep draft from entering the river.

Refining of oil in Mexico at Tampico and Minititlan increased considerably, as shown by the increase in importation of crude oil from the United States, from 17,523,440 barrels in 1908 to 27,554,581 barrels in 1909.

Production.—The best available estimate of the production of petroleum in 1907, 1908, and 1909 in Mexico is as follows:

Production of petroleum in Mexico in 1907, 1908, and 1909.

1907	barrels	1,000,000
1908	do	3,481,410
1909	do	2,488,742

The following table shows the quantity of crude petroleum, naphtha, and illuminating oil imported from the United States into Mexico in 1907, 1908, and 1909:

Imports of petroleum and its products from the United States into Mexico, years ending June 30, 1907, 1908, and 1909.

Kind of oil.	1907		1908		1909	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Gallons.		*Gallons.*		*Gallons.*	
Crude	19,992,434	$1,037,226	17,523,440	$901,115	27,554,581	$1,184,398
Naphtha	133,147	22,069	79,686	17,756	73,819	11,417
Illuminating	2,495,070	252,020	764,067	114,655	511,276	69,224
Lubricating	1,255,991	236,074	839,966	178,865	1,165,272	214,457
Total	23,876,642	1,547,389	19,207,159	1,212,391	29,304,948	1,479,496

Quantity and value of mineral oils imported from the United States into Mexico, 1900 to 1909, inclusive.

Year ending June 30—	Mineral.			
	Crude.		Refined, including residuum.	
	Quantity.	Value.	Quantity.	Value.
	Gallons.		*Gallons.*	
1900	8,002,845	$455,372	1,056,893	$208,767
1901	8,356,258	432,022	918,017	168,773
1902	10,844,913	550,694	1,224,589	209,508
1903	9,859,154	559,332	1,153,015	218,272
1904	10,938,448	663,575	1,179,894	222,005
1905	14,036,517	786,613	1,216,421	224,061
1906	14,366,495	766,353	3,295,325	616,479
1907	19,992,434	1,037,226	3,906,472	511,990
1908	17,523,440	901,115	1,683,719	311,276
1909	27,554,581	1,184,398	1,750,367	295,098

PERU.

The number of wells producing petroleum in Peru in 1907 was 565, as against 200 in 1906. The output was obtained from the Departments of Piura and Tumbes and the province of Huancane. The American Titicaca Oil Company, which started boring near Pusi in the province of Huancane, where oil has been struck at a very shallow depth, obtained 2,000 tons in 1907, as compared with 182 tons in 1906. It is expected that the petroleum deposits of the Titicaca region will prove in the near future much more important than those of northern Peru.

Concessions.—The number of petroleum concessions registered in the Departments of Peru in 1907 was as follows:

Number of petroleum concessions registered in the Departments of Peru in 1907.

	Department.	District.	Number.
Northern Peru	Piura	Lobitos, Negritos	2,021
	Tumbes	Zorritos	794
Southern Peru	Cuzco		330
	Puno	Lake Titicaca	1,436
Total			4,581

Production.—The production of petroleum in Peru in recent years is shown in the following tables:

Production of petroleum in Peru, 1900–1909, in tons and barrels.

Year.	Production.	
	Metric tons.	Barrels.
1900	a 36,640	274,800
1901	a 36,640	274,800
1902	a 38,230	286,725
1903	37,079	278,092
1904	38,683	290,123
1905	59,720	447,880
1906	71,506	536,294
1907	100,830	756,226
1908	134,824	1,011,180
1909	175,482	1,316,118

a Estimated. One metric ton=7.5 barrels.

Production of petroleum in Peru, 1905–1909, by districts, in barrels.

Year.	Lobitos.	Negritos.	Zorritos.	Lake Titicaca (Huancane).	Total.
1905	a 75,000	335,160	37,720	....	447,880
1906	162,000	330,510	42,419	1,365	536,294
1907	279,000	396,750	65,476	15,000	756,226
1908	319,898	548,750	71,429	a 76,103	1,011,180
1909	429,195	740,070	70,750	a 76,103	1,316,118

a Estimated.

In the following table are given, so far as can now be ascertained, the production, shipments, and stocks of petroleum and the number of producing wells in the Lobitos oil field of Peru in the years 1905 to 1909, inclusive:

Production, shipments, and stocks of petroleum, and number of producing wells in Lobitos oil field, 1905–1909.

Year.	Production.		Shipments.	Stocks, December 31.	Producing wells, January 1.
	Metric tons.	*Barrels.*	*Metric tons.*	*Metric tons.*	
1905	a 10,000	75,000	....	....	....
1906	a 21,600	162,000	17,576	....	....
1907	a 37,200	279,000	25,821	4,816	....
1908	42,653	319,898	36,131	8,860	26
1909	57,226	429,195	54,289	11,797	62

a Estimated.

The following table gives the production of petroleum in the Negritos oil field of Peru from 1904 to 1909, in tons and barrels:

Production of petroleum in Negritos oil field, Peru, 1904–1909.

Year.	Production.	
	Metric tons.	Barrels.
1904	39,508	296,310
1905	44,688	335,160
1906	44,068	330,510
1907	52,900	396,750
1908	72,500	543,750
1909	98,676	740,070

Production of petroleum in Zorritos oil field of Peru, 1900–1909, in gallons.

Year.	Crude petroleum.	Refined.[a]	Gasoline.	Benzine.
1900	4,325,000	400,000	13,000	
1901	3,135,000	282,430	19,060	
1902	2,489,500	373,250	25,920	
1903	2,060,000	276,100	61,745	
1904	2,080,000	365,000	46,200	
1905	1,584,242	300,000	29,570	
1906	1,781,600	350,000	54,000	10,000
1907	2,750,000	420,000	101,000	20,000
1908	3,000,000	500,000	150,000	30,000
1909	2,971,510	469,610	96,520	....

[a] Kerosene.

TRINIDAD.

During the year 1909 the island of Trinidad was prospected energetically for petroleum, not only because of seepages of oil and gas, but because of the success in Mexico in searching for oil near asphalt deposits. The results are encouraging. Such authorities as Mr. A. Beebe Thompson state that oil prospecting in Trinidad has passed the experimental stage and that profitable supplies are assured.

At the Mayaro fields, 35 miles east of Port of Spain, active work has been resumed, and the Oil Exportation Company is now building and repairing roads and bridges and getting in machinery.

The New Trinidad Asphalt Company, operating at Pitch Lake and Brighton, is erecting two large storage tanks, and is drilling.

The Trinidad Petroleum Company, at Guapo, is reported by Mr. Thompson as having found oil in considerable quantity in all its recent wells, and also much gas. Fuel oil is used in drilling.

BARBADOS.

Petroleum has been produced in small quantities in connection with the asphalt (manjak) deposits of Barbados, which have been worked in a small way for many years. According to Consul Chester W. Martin, a company has lately been organized in London with a capital of $1,500,000 for the systematic exploration of the island for oil.

VENEZUELA.

According to Consul Ralph J. Totten,[a] of Maracaibo, there are five petroleum districts in or bordering on Venezuela, as follows: Mara, where seepages of petroleum were found near the Limon River asphalt lake; Bella Vista, near Maracaibo; the district of Sucre, where seepages are found over a large area, together with asphalt deposits; Sardinate, on Sardinate River in Colombia, near the Venezuelan frontier, where the oil is used locally; Colon, in the State of Zulia, south of Lake Maracaibo. Consul Totten states that wells are to be sunk in the near future in the Bella Vista field and a general exploration of all five districts is to be undertaken by Maracaibo merchants. He states that the oil field can be reached by light-draft steamers by way of Catumbo River, 70 miles to its junction with the Tarra, and about 50 miles up this stream to the village of La Paloma, where the oil seepages begin. The area is large.

Abundant evidence of petroleum is to be found close at hand on some rugged hills, 125 to 150 feet above the level of the river. From these hills run some 20 small streams. The water is constantly covered with a thick coating of petroleum. Some of the oil comes from springs and some from fissures along the stream banks. In one of these fissures an excavation 3 feet deep by 2 feet square has been made. It fills with crude oil in about six hours. There are many exudations of asphalt.

The crude oil is of two classes. One is thin enough to flow readily and has a specific gravity of 0.8837 at 15° C.; the other is very thick, like coal tar. Both contain asphalt, resembling Texas oils. Distillation of the thin oil showed 0.5 per cent below 120° C., 0.5 per cent between 120° and 170°, 14 per cent between 170° and 235° (illuminating oil), 28 per cent between 235° and 270° (heavy illuminating oil), 51 per cent between 270° and 370° (lubricating, etc.), and 6 per cent of coke. The thick oil showed 28 per cent of water, no gasoline or burning oil, and 11 per cent of coke.

COLOMBIA.

According to United States Consul General White at Bogota seepages of petroleum and natural gas are frequent and very pronounced over a great range of territory in Colombia. The eastern and central mountain chains are composed of old crystalline rocks; the western chain consists chiefly of Cretaceous rocks. Above these Cretaceous deposits are Tertiary and Quaternary beds of various sorts, which form the plains of the seacoast, parts of the river valleys, including the great llanos to the east, and many of the foothills and plateaus of the mountain region.

The petroleum deposits appear to belong to the Cretaceous system and are found where this system is in evidence, or in the deposits immediately overlying it. The known deposits of oil are on the plains near the coast of the Atlantic (Caribbean Sea), in the river valleys, along the foothills of the mountains, and at various points in the western chain of mountains where are the beds overlying the Cretaceous system. It would appear probable that the movements

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[a] Daily Cons. Rept., August 22, 1910.

of the earth which have produced the mountain systems of Colombia have also thrown these beds into a series of folds, synclinal and anticlinal, so that they afford at many places formations favorable to the storage of oil in large quantities.

There are indications of oil all along the Atlantic seaboard from the Atrato River region to the Magdalena. Baron Humboldt noted the gas seepages and they have attracted the attention of all visitors since. The oil seepages in this region have also been noted by many writers. The principal regions where seepages have been noticed in Colombia are as follows: Tubara, Atrato, Richacha, lower Magdalena River, Cesar River Valley, Lebrija River Valley, Ocaña, Carare River, Sogomoso River, table lands of Boyaca, upper Magdalena River, near Honda and Ambalena, near Chaparral and Saldaña River, near Girardot and Carmen, and north and south of Medina in the foothills northeast of Bogota.

These occurrences are described in detail in the report of Mr. Jay White, United States consul general at Bogota, Colombia, of March 29, 1909, which can be consulted in the Consular Bureau, Washington, D. C., and from which these extracts have been taken.

ARGENTINA.

Petroleum has been found in the Provinces of Salta and Jujuy, in the northern part of the Republic, and a factory has been erected at Campana for refining the oil.

A new oil field has been opened in Patagonia, near Rivadavia, in the territory of Chubut. A 4-inch well 1,770 feet deep flowed 13 tons a day of very heavy asphaltic oil, showing naphtha 2.5 per cent, kerosene 4.7 per cent, asphalt 55.4 per cent. The Government has reserved part for a State monopoly, but has given out 10 concessions to private enterprise.

RUSSIA.

PRODUCTION.

The Russian production increased about 8 per cent, as shown by the tables which follow. The Grosny field led in the increase, the product coming from pumped wells to a greater extent than ever. So long as the Grosny production is thus increasing it is entirely premature to predict, as has been done so vigorously in the British press, that the Apsheron product is doomed to replacement by oil from the Maikop district in Kuban, so much more accessible to Tuapse on the Black Sea. The Maikop field has great advantages from this point of view, and much can be said in its favor from geological and other theoretical considerations, but there is so far nothing to give it prominence beyond speculative activity in London. Many questions must be answered concerning actual production of oil and longevity of wells before the Maikop field can rank in importance even with the Caddo (La.) oil field in the United States, and some time may elapse before its total product equals that of one gusher in California.

The tables following give the statistics of the Russian petroleum industry.

Production of petroleum in Russia, 1900–1909, by fields.

Year.	Baku.		Grosny.		Total.	
	Poods.[a]	Barrels of 42 gallons.	Poods.	Barrels of 42 gallons.	Poods.	Barrels of 42 gallons.
0	600,763,707	72,120,493	30,478,837	3,658,924	631,242,544	75,779,417
1	674,543,724	80,977,638	34,910,347	4,190,918	709,454,071	85,168,556
2	636,529,000	76,414,045	34,369,572	4,125,999	670,898,572	80,540,044
3	596,581,155	71,618,386	33,094,000	3,972,870	629,675,155	75,591,256
4	614,115,445	73,723,290	40,095,331	4,813,365	654,210,776	78,536,655
5	414,762,000	49,791,356	43,057,052	5,168,914	457,819,052	54,960,270
6	447,520,000	53,723,889	38,373,603	4,606,675	[b] 490,614,603	58,897,311
7	476,002,000	57,143,097	39,214,612	4,707,637	515,216,612	61,850,734
8	465,343,000	55,863,504	52,058,895	6,249,567	[c] 518,013,116	62,186,447
9	492,500,000	59,123,650	57,033,015	6,846,700	549,533,015	65,970,350

[a] 8.33 poods crude=1 United States barrel of 42 gallons.
8 poods illuminating oil=1 United States barrel of 42 gallons.
8.18 poods lubricating oil=1 United States barrel of 42 gallons.
9 poods residuum=1 United States barrel of 42 gallons.
7.50 poods naphtha=1 United States barrel of 42 gallons.
8.3775 poods other products=1 United States barrel of 42 gallons, estimated.
1 pood=36.112 pounds.
1 kopeck=1.958 cents.
[b] Includes 4,721,000 poods, or 566,747 barrels, produced in Bereki and Tchimion oil fields in 1906.
[c] Includes 611,221 poods produced at Surakhany.

The total production of crude petroleum on the Apsheron Peninsula nd the shipments of the chief petroleum products from Baku to all oints from 1900 to 1909 have been as follows:

otal production of crude petroleum on the Apsheron Peninsula and shipments of petroleum products from Baku, 1900–1909, in barrels.

Year.	Production.	Shipments from Baku.					
		Illuminaing.	Lubricating.	Other products.	Residuum.	Crude oil.	Total.
00	75,005,326	15,431,250	1,639,486	240,048	29,301,667	4,799,280	51,411,731
01	84,216,743	16,072,500	1,615,403	126,410	35,286,778	4,334,574	57,435,665
02	76,414,045	15,026,000	1,750,367	298,657	38,049,555	4,090,036	59,214,615
03	71,618,386	18,313,125	2,032,347	117,815	33,763,778	3,172,509	57,399,574
04	73,723,290	19,205,250	1,896,455	159,355	33,622,111	2,249,340	57,132,511
05	49,791,356	9,209,125	1,303,912	150,045	29,555,777	2,897,359	43,116,218
06	53,723,889	8,941,125	1,847,799	179,289	22,697,667	4,001,441	37,667,321
07	57,143,097	11,450,019	1,724,664	565,689	27,833,892	4,290,500	45,864,764
08	55,863,504	10,682,750	1,754,034	105,163	23,989,778	5,398,200	41,929,925
09	59,123,650	8,261,368	1,728,833	1,087,115	23,404,954	6,182,973	40,665,243

The division of the production among the districts of the Apsheron eninsula or Baku field is as follows:

Production of the several districts of the Apsheron Peninsula, 1900–1909, in barrels.

Year.	Balakhani.	Sabunchi.	Romani.	Bibi-Eibat.	Binagadi.	Total.
00	14,967,598	30,208,182	13,785,820	13,110,092	48,801	72,120,493
01	14,139,716	35,444,697	15,297,031	16,039,998	56,196	80,977,638
02	12,185,354	32,071,908	16,800,000	15,298,200	58,583	76,414,045
03	10,642,274	27,663,859	14,398,951	18,882,294	31,008	71,618,386
04	9,848,380	26,029,292	16,063,505	21,745,618	36,495	73,723,290
05	6,866,747	16,494,310	11,230,732	15,175,558	24,009	49,791,356
06	8,142,017	18,739,015	11,489,796	15,317,647	35,414	53,723,889
07	8,594,118	22,036,734	10,750,901	15,761,344	....	57,143,097
08	8,363,860	23,727,367	9,392,557	14,379,720	....	55,863,504
09	8,763,505	24,873,950	10,492,198	14,753,901	[a] 240,096	59,123,650

[a] Other.

Production of petroleum from pumping and flowing wells in the Baku field, 1900–1909, by districts, in barrels.

Year.	Balakhani.	Sabunchi.	Romani.	Bibi-Eibat.	Binagadi.	Total.
PUMPING.						
1900	14,967,598	28,870,127	10,175,676	9,915,098	48,801	63,977,300
1901	14,139,716	30,888,382	12,263,970	11,470,178	44,192	68,806,438
1902	12,185,354	30,853,901	12,172,389	9,765,667	58,583	65,035,894
1903	10,642,274	27,302,022	12,822,336	14,396,376	31,008	65,194,016
1904	9,848,380	25,384,514	15,043,217	19,061,944	36,495	69,374,550
1905	6,866,747	16,265,306	9,927,971	14,861,945	24,009	47,945,978
1906	8,142,017	18,513,445	10,436,615	15,282,113	35,414	52,409,604
1907	8,594,118	21,676,950	10,353,782	15,137,215	...	55,762,065
1908	8,363,860	23,585,230	9,250,060	13,529,900	...	54,729,050
1909	8,763,505	24,849,940	9,843,938	12,953,181	[a] 192,077	56,602,641
FLOWING.						
1900	...	1,338,055	3,610,144	3,194,994	...	8,143,193
1901	...	4,556,315	3,033,061	4,569,820	12,004	12,171,200
1902	...	1,218,007	4,627,611	5,532,533	...	11,378,151
1903	...	361,837	1,576,615	4,485,918	...	6,424,370
1904	...	644,778	1,020,288	2,683,674	...	4,348,740
1905	...	229,004	1,302,761	313,613	...	1,845,378
1906	...	225,570	1,053,181	35,534	...	1,314,285
1907	...	359,784	397,119	624,129	...	1,381,032
1908	...	142,137	142,497	849,820	...	1,134,454
1909	...	24,010	648,260	1,800,720	[a] 48,019	2,521,009

[a] Other.

The Grosny petroleum industry during 1909.—The total production of the Grosny field in 1909 amounted to 57,033,015 poods, as against 52,058,895 in 1908, showing an increase of 5,000,000 poods, or nearly 10 per cent. Although this increase is not so large as that from 1907 to 1908 (32 per cent), it is of more importance, as it is almost entirely due to the production of bailed and not of flowing wells. There was, namely, produced by bailing 50,997,451 poods, against 37,741,980 poods in 1908, showing an increase of over 35 per cent.

For sixty years the Grosny fields were exploited by means of hand-dug wells, and produced 3,479,000 poods, but in 1893 boring was introduced, and since then the bored wells have yielded 527,971,637 poods, so that prior to January 1, 1910, the total crude oil production of Grosny amounted to 531,450,647 poods. The average daily production per well was very large 15 years ago, but since that time it first rapidly and then slowly diminished. In 1898 it was 1,500 poods, in 1908 only 750 poods; but since then it has increased, and in December, 1909, was over 900 poods, thus reaching a limit considerably higher than that at Baku, though in November, 1909, the average was only 650 poods per well.

In 1908 the oil at Grosny was obtained from 42 plots, in 1909 from 45 plots, but the three new plots have not yet yielded much oil, owing to limited exploitation.

Energetic boring took place throughout the year 1909, amounting to 11,516 sagenes (80,612 feet),[a] which illustrates the fact of the tendency of the production to a regular development, which is aided as well by a more and more extensive utilization of natural gas as fuel.

During 1909 on many plots in Grosny, natural gas was utilized as fuel for boilers, buildings, motors, and even for lighting purposes. Naturally, the quantity of petroleum used as fuel considerably diminished.

The following table shows the production in the Grosny field from 1906 to 1909:

Production of petroleum in the Grosny oil field, 1906–1909, in barrels.

Year.	Pumping.		Flowing.		Total.	
	Poods.	*Barrels.*	*Poods.*	*Barrels.*	*Poods.*	*Barrels.*
1906	30,041,912	3,606,472	8,331,691	1,000,203	38,373,603	4,606,67
1907	33,840,762	4,062,517	5,373,850	645,120	39,214,612	4,707,63
1908	37,741,980	4,530,850	14,316,915	1,718,717	52,058,895	6,249,56
1909	50,997,451	6,122,143	6,035,564	724,557	57,033,015	6,846,70

[a] 1 sagene = 7 feet.

Well record in the Grosny field in 1907–1909.

Year.	Total wells.	Producing, December 31.	Boring and deepening, December 31.	Average depth of wells.	Total sum of depth of producing wells.
				Feet.	*Feet.*
907	271	205	45	....	185,346
908	287	172	51	1,348.2	203,574
909	320	182	58	1,458.1	250,831

The following table shows the deliveries of petroleum and petroleum roducts from the Grosny district from 1906 to 1909:

eliveries of petroleum and petroleum products from the Grosny district, 1906–1909, in barrels.

Year.	Crude oil.	Kerosene.	Benzine.	Residuals.	Total.
906	150,825	363,649	178,568	2,462,484	3,155,526
907	209,584	243,170	342,306	2,199,756	2,994,816
908	164,294	400,139	288,783	3,061,256	3,914,472
909	....	....	....	....	....

Novorossisk.—The following table shows the shipments of petroleum nd its products from Novorossisk from 1906 to 1909:

Shipments of petroleum from Novorossisk, 1906–1909.

Year.	Crude oil.	Illuminating.	Benzine.	Residuals.	Total.
	Barrels.	*Barrels.*	*Barrels.*	*Barrels.*	*Barrels.*
906	486	435,670	86,230	347,858	870,244
907	770	246,246	299,658	209,812	756,486
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*
907	....	34,414	31,543	24,922	90,879
908	....	15,943	39,137	18,261	73,341
909	....	....	....	....	....

Batum.—The receipts of oils at Batum and the deliveries therefrom or the last five years are given in the following table:

Receipts and deliveries of petroleum at Batum, 1905–1909.

Year.	Receipts.		Deliveries.	
	Poods.	*Barrels.*	*Poods.*	*Barrels.*
905	25,743,344	2,647,900	36,763,124	3,781,349
906	31,607,655	3,247,644	30,999,197	3,188,500
907	39,467,780	4,059,534	37,073,586	3,813,283
908	44,625,829	4,434,633	43,250,065	4,325,182
909	....	....	....	....

Stocks at Batum.—The following were the stocks of petroleum products held at Batum at the close of the year from 1907 to 1909, in poods and barrels:

Stocks of petroleum at Batum, December 31, 1907–1909.

	1907		1908		1909	
	Poods.	*Barrels.*	*Poods.*	*Barrels.*	*Poods.*	*Barrels.*
Illuminating	4,232,000	529,000	3,484,000	435,500	2,700,000	350,000
Lubricating	1,273,000	155,623	1,124,000	137,410	972,000	118,826
Solar oil	....	....	97,000	11,758	24,000	3,000
Vaseline	69,000	7,909	23,000	2,644	158,000	18,860
Residuals	257,000	28,556	714,000	79,333	577,000	64,111
Total	5,831,000	721,088	5,442,000	666,645	4,431,000	554,797

Well record.—In the table following is given a statement of the number and condition of the wells on the Apsheron Peninsula on December 31, 1908 and 1909:

Number and condition of wells in the Baku fields in years ending December 31, 1908 and 1909.

Condition of wells.	Balakhani-Sabunchi.		Romani.		Bibi-Eibat.		Total.	
	1908	1909	1908	1909	1908	1909	1908	1909
Completed	146	143	34	36	48	41	228	220
Producing, Dec. 31	2,211	1,611	317	197	429	273	2,957	2,081
Trial pumping, Dec. 31	819	47	151	8	253	9	1,223	64
Drilling, Dec. 31	179	128	28	33	24	47	231	208
Drilling deeper, Dec. 31	203	150	80	54	130	58	413	262
Cleaning out and repairing	258	27	151	15	162	7	571	54
Standing idle	600	1,079	100	216	195	121	895	1,416
Rigs up, ready for drilling	170	60	24	10	21	12	215	82
New wells sunk	417	143	51	36	28	41	496	220
Length of wells drilled, in feet	34,249	226,191	9,134	68,026	12,901	68,257	56,284	362,474

Stocks in the Baku field.—The stocks of petroleum and petroleum products in the Baku field at the close of 1906, 1907, 1908, and 1909 were as follows:

Stocks of petroleum in Baku, December 31, 1906–1909, in barrels.

	1906	1907	1908	1909
At oil wells: Crude	930,965	720,288	1,032,413	1,080,432
At refineries:				
Crude	2,187,339	2,028,812	1,239,736	2,495,087
Illuminating	953,751	1,225,000	675,375	938,971
Lubricating	387,217	268,949	195,600	247,358
Residuals	4,669,882	3,822,222	4,804,333	4,703,372
Other products	92,762	179,051	119,370	234,048
Total	9,221,916	8,244,322	8,066,827	9,699,268

AUSTRIA-HUNGARY.

The development of large supplies of natural gas in Hungary during the year led to the appointment of a commission by the Austrian Government to investigate the methods of utilization of natural gas in the United States.

GALICIA.

Production.—The production of petroleum in Galicia increased from 12,612,295 barrels in 1908 to 14,932,799 in 1909. The product nearly doubled in two years, and is now almost three times the product of 1907. This constant increase and a great increase in stocks led to a marked decline of prices at the end of 1908 and in the early part of 1909. But the Government steadied the market by agreeing to build storage and to make advances against the oil deposited. The increase in price, on the other hand, had the effect of disturbing the development of the fuel-oil trade. The action of the Government did as much toward steadying the market as could be expected with the increase in stocks, and prices gained considerably during the year.

In the following table is given a statement of the production of petroleum in Galicia from 1900 to 1909, inclusive:

Production of petroleum in Galicia, 1900–1909.

Year.	Metric centners.[a]	Barrels of 42 gallons.	Year.	Metric centners.[a]	Barrels of 42 gallons.
1900	3,263,340	2,346,505	1905	8,017,964	5,765,317
1901	4,522,000	3,251,544	1906	7,604,432	5,467,967
1902	5,760,600	4,142,159	1907	11,759,740	8,455,841
1903	7,279,710	5,234,475	1908	17,540,220	12,612,295
1904	8,271,167	5,947,383	1909	20,767,400	14,932,799

[a] One metric centner or quintal=100 kilograms (220.462 pounds); 1 metric centner or quintal of crude petroleum=0.71905 barrel of 42 gallons.

In the following table is given the production of petroleum in Galicia in 1905 to 1909, inclusive, by fields, in tons:

Production of petroleum in Galicia, 1905–1909, by fields, in metric tons.[a]

Field.	1905	1906	1907	1908	1909
East Galicia:					
Tustanowice } Boryslaw }	546,556	562,198	1,011,590	1,318,710	1,706,435
				266,910	231,195
Schodnica	60,202	47,151	39,650	36,480	37,860
Urycz	20,347	17,930	13,510	} 30,022	25,110
Mraznica	....	....	1,490		
Other fields	14,246	13,830	12,230		
West Galicia:					
Potok	22,479	16,325	13,850	} 50,640	41,600
Rogi	24,234	11,452	9,033		
Rowne	1,609	1,536	1,981		
Krosno	43,559	34,268	29,960		
Tarnawa-Wielopole-Zagorz	[b] 32,956	[c] 24,870	17,390	18,200	6,770
Kobylanka, Kryg, Zalawie, Lipinki, Libusza, etc	35,608	30,883	25,290	33,060	27,770
Total	801,796	760,443	1,175,974	1,754,022	2,076,740

[a] 1 metric ton=7.1905 barrels of crude petroleum of 42 gallons=2,204.62 pounds.
[b] Tarnawa-Wielopole.
[c] Tarnawa.

Deliveries of Galician petroleum to refineries in 1907, 1908, and 1909, in metric tons.

	1907	1908	1909
Delivered to refineries in—			
Galicia and Bucovina	281,344	457,020	571,290
Austria	422,829	540,820	672,980
Hungary	272,995	338,720	384,090
Total	977,168	1,336,560	1,628,360

It is reported that the stocks of crude petroleum in Boryslaw and Tustanowice increased from 1,048,110 metric tons at the close of 1908 to 1,454,570 tons at the close of 1909, an increase of 406,460 tons.

Well record.—A record of the number of oil wells at Boryslaw and Tustanowice at the close of 1909 was as follows:

Well record at Boryslaw and Tustanowice December 31, 1909.

	Boryslaw.	Tustanowice.
Producing wells	36	97
Abandoned wells	5	29
Drilling wells		22
Wells over 1,000 meters, but nonproducing		99
Wells of less than 1,000 meters	3	43
Wells about to be drilled	7	
Total	51	290

Imports and exports.—In the following table are given the imports and exports of petroleum products into and from Austria-Hungary in 1907, 1908, and 1909:

Imports and exports of petroleum into and from Austria-Hungary in 1907, 1908, and 1909, in metric tons.

Kind.	1907		1908		1909	
	Imports.	Exports.	Imports.	Exports.	Imports.	Exports.
Illuminating oils	2,717	141,572	1,868	234,160	1,761	290,915
Lubricating and other oils	16,079	63,250	16,268	111,060	19,614	130,862
Benzine	8	12,637	8	25,597	10	32,528
Paraffin	313	14,737	357	28,666	507	38,042
Crude petroleum	18,342	8,250	3,114	6,250		51,558
Total	37,459	240,446	21,615	405,733	21,892	543,905

ROUMANIA.

Roumania showed a rapid gain in petroleum production from 1900 to 1907, but in 1908 this rate of increase was checked to such an extent that oil was imported from the newly developed additions to Galicia's oil fields. This was necessary in order to supply the increased capacity of the Roumanian refineries. Roumania has wooed foreign capital for the petroleum industry with notable success, but the investment has not been so much in petroleum lands as in refineries. As a result the needs of these refineries had by 1908 outstripped the production of oil, which had been pushed to the full capacity of the developed producing areas. The outlook for 1909, therefore, was for a decline in production and for increased importation. But by one of the surprises characteristic of the field new supplies were developed, restoring the normal rate of increase, and importation ceased. In January the Standard Oil Company developed a good well at Bordeni, which indicated a considerable extension of the great Bustenari field.

In July, 1909, the Steaua Romana Company obtained a large well in the well-known field of Tzintea in the Prahova district, and this, with the consequent stimulus to drilling and with increases in the Moreni and the Câmpina fields, brought the total production from 8,252,157 barrels in 1908 to 9,321,138 barrels in 1909, valued at $11,279,360. Every district increased its production, as is shown in the table of production by districts. The Tzintea field increased from 146,719 barrels in 1908 to 835,190 barrels in 1909.

The total production in Roumania from 1857 to the close of 1909 aggregated 60,000,000 barrels.

Including pipe lines, tank cars, special railroad and terminal facilities, the total investment in the petroleum industry in Roumania has been estimated at $62,000,000, of which $26,000,000 is German and $4,500,000 American. The principal other investing countries are France, Italy, Holland, England, and Russia. The experiment of regulating by law the proportion of domestic trade which each refinery shall furnish is still continued with modifications. The publication by the Government of detailed statements of the work of each refinery makes it possible to publish a table showing the average yield of various refined products, residuum, etc., from the 8,000,000 barrels of crude treated in Roumanian refineries in 1909.

Percentage of refined products from Roumanian crude petroleum in 1909.

Product.	Per cent.
Crude benzine	18.0
Illuminating oil	23.8
Lubricating oil	3.92
Residue	52.44
Loss	2.05

The yield of benzine is satisfactory, but the yield of illuminating oils and of lubricants is very low compared with the United States products.

In 1888 only 1.5 per cent of the fuel used on the Roumanian railways was oil; in 1908 oil formed 62.2 per cent, or 180,000 metric tons.

The following table shows the progress made in every branch of the Roumanian petroleum industry during the last five years:

Roumanian petroleum industry, 1905–1909.

[Metric tons.]

	1905	1906	1907	1908	1909
Crude-oil production	614,870	887,091	1,129,097	1,147,727	1,296,403
Crude oil treated at refineries	510,143	748,798	950,614	1,012,616	1,107,825
Output of refineries:					
Benzine	78,182	114,428	146,263	180,190	201,253
Illuminating oil	153,499	221,683	261,684	248,274	263,998
Lubricating oil	17,255	53,588	57,337	89,753	43,446
Residuals	237,677	333,714	452,685	473,770	576,600
Home consumption:					
Benzine	2,696	4,059	5,689	9,055	14,041
Illuminating oil	31,558	35,243	38,467	38,422	39,451
Lubricating oil	6,307	9,848	9,047	11,955	15,698
Residuals	162,243	237,477	332,999	347,323	366,703
Fuel at the refineries				113,753	109,077
Exports:					
Benzine	46,696	79,493	89,522	122,860	108,218
Illuminating oil and distillate	118,134	190,914	262,489	263,633	261,637
Crude, residuals, etc	49,515	54,799	78,423	78,765	49,715
Paraffin			151	187	545
Stocks on December 31:					
Benzine	20,084	18,275	47,506	44,783	40,071
Illuminating oil	30,144	48,967	36,128	41,541	79,613
Lubricating oil and residuals	64,452	67,334	67,816	73,761	157,204

The statistics given below have been furnished by the Moniteur du Pétrole Roumain.

Production.—In the following table is given the production of petroleum in Roumania, by districts and months, during the year 1909, in metric tons:

Production of petroleum in Roumania in 1909, by districts and months, in metric tons.[a]

Month.	District Prahova.					Dimbovitza.	Buzeu.	Bacau.	Total.
	Bustenari.	Câmpina-Poiana.	Moreni.	Other.	Total.				
January	35.208	18.565	23.842	5.359	82.974	2.574	1.766	1.602	88.916
February	33.132	18.553	27.521	4.821	84.027	2.157	1.946	1.523	89.653
March	36.977	23.567	24.357	10.750	95.651	2.295	1.949	1.707	101.602
April	34.948	28.336	29.217	9.647	102.148	2.028	2.203	1.792	108.171
May	36.771	27.881	32.069	10.575	107.296	2.494	2.180	1.660	113.630
June	34.104	22.551	32.769	14.341	103.765	2.254	2.188	1.677	109.884
July	32.802	25.201	37.374	16.100	111.477	2.018	2.172	1.572	117.239
August	31.008	26.871	33.703	18.265	109.847	2.798	2.271	1.398	116.314
September	29.512	26.002	36.705	12.291	104.510	2.837	2.159	1.460	110.966
October	30.869	30.347	27.065	15.906	104.187	3.183	2.186	1.588	111.144
November	28.152	31.080	27.299	15.527	102.058	2.745	2.267	1.500	108.570
December	29.759	32.193	37.863	13.887	113.702	2.905	2.102	1.605	120.314
Total	393.242	311.147	369.784	147.469	1,221.642	30.288	25.389	19.084	1,296.403

[a] 1 metric ton=7.19 barrels of 42 gallons.

Well record.—The well record in Roumania in 1908 and 1909 is shown in the following table:

Well record in Roumania at close of 1908 and 1909, by districts.

District.	December 31, 1908.						December 31, 1909.					
	Bore holes.			Hand wells.			Bore holes.			Hand wells.		
	Producing.	Drilling.	Abandoned.	Producing.	Sinking.	Abandoned.	Producing.	Drilling.	Abandoned.	Producing.	Sinking.	Abandoned.
Prahova	600	265	271	137	94	452	647	238	402	157	41	499
Dambovitza	15	11	20	83	19	89	14	11	12	68	18	77
Buzeu	7	7	18	59	9	58	21	16	15	44	2	63
Bacau	59	18	50	304	27	486	66	24	52	299	30	476
	681	301	359	583	149	1,085	748	289	481	568	91	1,115

The production of petroleum in Roumania in the last ten years has been as follows:

Production of petroleum in Roumania, 1900–1909, in barrels.

Year.	Quantity.	Year.	Quantity.
1900	1,628,535	1905	4,420,987
1901	1,678,320	1906	6,378,184
1902	2,059,935	1907	8,118,207
1903	2,763,117	1908	8,252,157
1904	3,599,026	1909	9,321,138

Exports.—The export trade in petroleum products from Roumania was less active in 1909 than in 1908. This applied to all products and resulted in a corresponding increase in stocks in Roumania. The increase was particularly great in residuum, because of the increased production of oil in Moreni and Tzintea. These crude oils contain relatively less naphtha and illuminating oils.

In the following table are given the exports of petroleum products from Roumania in the years 1908 and 1909, in tons:

Exports of petroleum products from Roumania in 1908 and 1909, in metric tons.

Kind.	1908	1909
Crude oil, gas oil, lubricating oil, and residuals	76,196	49,715
Illuminating oil	262,176	261,637
Benzine	122,332	108,216
Paraffin scale	....	483
Total	460,704	420,051

GERMANY.

In the following table are shown the quantity and value of petroleum produced in the German Empire, by States, from 1900 to 1909, inclusive:

Production and value of petroleum in the German Empire, 1900–1909, by States.

Year.	Alsace-Lorraine.	Prussia and Bavaria.	Total.		Total value.	
	Quantity.	Quantity.	Quantity.			
	Metric tons.	*Metric tons.*	*Metric tons.*	*Barrels (42 gallons).*	*Marks.*	*Dollars.*
1900	22,597	27,778	50,375	358,297	3,726,086	894,261
1901	19,997	24,098	44,095	313,630	2,950,478	702,213
1902	20,205	29,520	49,725	353,674	3,351,000	797,538
1903	20,947	41,733	62,680	445,818	4,334,000	1,031,492
1904	22,016	67,604	89,620	637,431	5,305,000	1,381,590
1905	21,128	57,741	78,869	560,963	5,207,000	1,239,266
1906	[a] 22,154	59,196	81,350	578,610	5,036,000	1,198,568
1907	[a] 26,124	80,255	106,379	756,631	7,056,000	1,679,328
1908	[a] 28,898	113,002	141,900	1,009,278	9,942,000	2,366,196
1909	(b)	(b)	143,244	1,018,837	10,118,000	2,408,084

[a] Includes Bavaria. [b] Not available.

1 metric ton, crude=7.1126 barrels.

GREAT BRITAIN.

Oil shale.—In the following table is shown the production of oil shale in Great Britain in 1900 and 1909, taken from the Mineral Statistics of the United Kingdom:

Quantity and value of oil shale produced in Great Britain, 1900–1909, in long tons.

Year.	England.		Scotland		Wales.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1900			2,279,879	$3,070,120	2,342	$4,773	2,282,221	$3,074,893
1901	388	$472	2,350,277	2,859,950	3,691	6,735	2,354,356	2,867,157
1902			2,105,953	2,434,277	1,581	2,886	2,107,534	2,437,163
1903	193	282	2,009,265	2,222,294	144	263	2,009,602	2,322,839
1904			2,331,885	2,695,578	1,177	2,146	2,333,062	2,697,725
1905	2,000	2,920	2,493,081	2,881,343	1,704	2,890	2,496,785	2,887,153
1906			2,545,724	3,200,449	798	1,358	2,546,522	3,201,807
1907			2,690,028	3,923,971			2,690,028	3,923,971
1908			2,892,039	3,870,118			2,892,039	3,870,118
1909			2,967,017	3,970,723			2,967,017	3,970,723

THE SCOTCH OIL SHALE INDUSTRY.

About forty years ago 50 companies produced oil from the Scotch shales. After the advent of American oil products and later of Russian oils, the number of companies began to drop till only 18 of the 50 were left thirty years ago, and these have now decreased to 6. Only 4 produced refined oils, viz, Pumpherston, Young's, Broxburn, and Oakbank. In all about 10,000 workmen find employment in the industry, which involves, besides distilling and refining operations the quarrying of about 3,000,000 tons of shale annually. The year

1908 yielded a satisfactory profit, but in 1909 decreased prices, due to the decline in the general petroleum situation, resulted in an unsatisfactory year, although the product increased. The decision of the British Admiralty to use fuel oil has, naturally, strengthened the industry. The production in 1909 included about 3.000.000 gallons of gasoline, 20.000.000 gallons each of illuminating and lubricating oil, 25.000 tons of paraffin wax, and 50.000 tons of sulphate of ammonia.

NEW SOUTH WALES.

The Commonwealth Oil Corporation continued in 1909 to expand its plant for producing oil from shale. The total output of this material is given in the following table:

Quantity and value of oil shale produced in New South Wales, 1900–1909, in long tons.

Year.	Quantity.	Value.
1900	22.862	$100.503
1901	54.774	201.906
1902	62.880	290.613
1903	34.776	139.265
1904	37.871	130.276
1905	38.226	103.399
1906	32.446	138.549
1907	47.331	154.996
1908	46.303	126.855
1909	....	....

NEW ZEALAND.

The Taranaki and Gisborne fields were prospected very energetically during 1909 and a careful investigation was made by the Government geological survey. Six companies were engaged in actual drilling, but it is still too soon to decide as to whether or not a commercial field will be developed. Analyses of these oils are given below. The oil districts are well described in the London Petroleum Review of May 7 and 16, 1910. They are further described in a private professional report by F. A. Rich, M. E., and in other reports which can be consulted in the United States Geological Survey, Washington, D. C.

Analysis of petroleum from New Zealand.

	Gisborne district.	Taranaki district.
Specific gravity of crude	0.8642	0.8495
Baumé gravity	32	34.8
Color	Green.	Brown.
Odor	Aromatic.	Aromatic.
Begins to boil, °C	210	97
Gasoline (to 150° C.) per cent	....	10
Specific gravity	....	.7805
Kerosene (150° to 300° C.) per cent	43	50
Specific gravity	.7300	.8281
Residuum, per cent	57.1	39.9
Specific gravity	.8923	.8969
Paraffin wax, per cent	8.88	14.78
Water	Trace.	Trace.

BRITISH INDIA.

The production in Burma and elsewhere in India is given in the table below. The fields are described in the recent report of consul E. A. Wakefield, available in the Bureau of Manufactures, Washington, D. C.

The following table gives the production of petroleum in India from 1900 to 1909 in imperial gallons reduced to barrels of 42 gallons and in rupees reduced to dollars:

Production and value of petroleum in India, 1900–1909.

Years.	Quantity.		Value.	
	Imperial gallons.	Barrels (42 United States gallons).	Rupees.[a]	Dollars.
1900	37,729,211	1,078,264	2,231,325	722,949
1901	50,075,117	1,430,716	3,065,131	993,102
1902	56,607,688	1,617,363	3,267,245	1,058,587
1903	87,859,069	2,510,259	5,315,470	1,722,212
1904	118,491,382	3,385,468	7,109,566	2,303,499
1905	144,798,444	4,137,098	9,063,051	2,936,429
1906	140,553,122	4,015,803	8,613,576	2,790,799
1907	152,045,677	4,344,162	9,150,225	2,968,637
1908	176,646,320	5,047,038	10,530,135	3,416,327
1909	233,678,087	6,676,517	13,652,580	4,429,352

[a] The value of the rupee is taken as 32.44⅓ cents; 15 rupees=£1.

Production of petroleum in India, 1905–1909, by provinces, in imperial gallons.

Province.	1905	1906	1907	1908	1909
Burma	142,063,846	137,654,261	148,888,002	173,402,790	230,396,617
Eastern Bengal and Assam	2,733,110	2,897,990	3,156,665	3,243,110	3,280,750
Punjab	1,488	871	1,010	420	720
Total	144,798,444	140,553,122	152,045,677	176,646,320	233,678,087

THE PETROLEUM IMPORT TRADE OF INDIA.

The statistics of petroleum imports into India during 1909, as compared with the figures for 1908, are as follows:

Imports of petroleum into India in 1908 and 1909, by countries, in imperial gallons.

Countries.	1908	1909
Russia	4,156,690	7,207,322
Roumania	20,907,685	3,919,632
Lund Archipelago	24,250,488	19,839,905
United States	31,431,505	39,547,142
Other countries	464	378
Total imports	80,747,014	70,514,379
From Burma	76,767,293	71,698,635
Grand total	157,514,307	142,213,014
Other products	12,990,989	14,187,532

ITALY.

In the following table will be found the production and value of petroleum in Italy from 1900 to 1909. This table is taken from the volumes of the Rivista del Servizio Minerario:

Production of petroleum in Italy, 1900–1909.

Year.	Number of wells in operation.	Quantity.		Value.	
		Metric tons.	United States barrels.	Lire.[a]	Dollars.
1900	9	1,683	12,102	491,769	94,911
1901	9	2,246	16,150	671,065	129,515
1902	9	2,633	18,933	778,163	150,185
1903	10	2,486	17,876	737,293	142,298
1904	10	3,543	25,476	1,053,294	203,286
1905	9	6,123	44,027	1,826,802	352,573
1906	12	7,451	53,577	2,226,559	429,726
1907	13	8,327	59,875	1,663,300	321,017
1908	14	7,088	50,966	1,415,640	273,219
1909	15	8,000	57,564	1,500,000	289,500

[a] Lira=$0.193. 1 metric ton, crude=7.1905 barrels.

SPAIN.

Indications of petroleum, long known in the Province of Cadiz, near Villamartin, were exploited in 1907 by drilling three wells, one less than 50 feet, the second 360 feet, and the third 200 feet. Very light-colored, light-gravity oil was obtained in small quantity. Samples of these oils, obtained through the United States Department of State, were analyzed with the following results:

Analysis of petroleum from Province of Cadiz, near Villamartin, Spain.

	1	2
Specific gravity of crude	0.7973	0.8018
Baumé gravity	45.6	44.6
Color	Amber.	Amber.
Odor	Aromatic.	Aromatic.
Begins to boil, ° C	87	108
Gasoline (to 150° C.), per cent	27.5	19.0
Specific gravity	.7375	.7414
Kerosene (150° to 300° C.), per cent	53.0	60.0
Specific gravity	.8088	.8000
Residuum, per cent	18.4	21.8
Specific gravity	.8727	.8708
Paraffin wax, per cent	2.52	3.20
Asphalt	None.	None.
Water	None.	None.
Unsaturated hydrocarbons in crude oil, per cent	5.6	7.6

In January, 1909, two small companies were formed, the Peninsular Oil Syndicate (Limited) and the Anglo-Spanish Oil Syndicate.

JAPAN.

In the following table is given the production of petroleum in Japan from 1900 to 1909, inclusive:

Production of petroleum in Japan, 1900–1909.[a]

[Barrels of 42 gallons.]

Year.	Crude.		Refined.	
	Koku.	*Barrels.*	*Koku.*	*Barrels.*
1900	767,092	871,416	52,323	59,439
1901	983,000	1,116,688		
1902	1,060,000	1,204,160		
1903	1,065,116	1,209,971	333,346	378,681
1904	1,249,536	1,419,473		
1905	1,296,482	1,472,804		
1906	1,501,563	1,705,776	582,138	661,309
1907	1,755,464	1,994,207	655,420	744,557
1908	1,815,001	2,061,841	698,833	793,874
1909	1,654,526	1,879,542		

[a] Excluding the island of Formosa.

1 koku=39.7 English gallons=47.46 United States gallons=1.136 United States barrels.

In the following table is given a statement of the production of petroleum in Japan, 1905–1908, by fields, as reported by the mining bureau of the department of agriculture and commerce, Tokyo:

Production of petroleum in Japan, 1905–1908, by fields.

Field.	1905	1906	1907	1908
NIIGATA PREFECTURE.				
Echigo:	*Koku.*	*Koku.*	*Koku.*	*Koku.*
Higashiyama	273,844	304,847	342,042	263,667
Nishiyama	271,495	294,277	360,115	492,393
Niitsu	634,704	808,655	970,556	807,002
Kubiki	97,075	76,578	63,572	62,938
Amaze	5,220	7,262	12,447	
Ojiya	14,180	9,964	6,732	7,097
Others (except Formosa)				6,450
Total quantity	1,296,482	1,501,563	1,755,464	1,639,547
Total value				$3,225,153

The following table, taken from the report of the Nagaoka Chamber of Commerce, gives the production of refined petroleum in Niigata Prefecture in the years 1908 and 1909:

Production of refined kerosene in Niigata Prefecture in 1908 and 1909.

Kind.	1908		1909	
	Koku.	*Barrels.*	*Koku.*	*Barrels.*
Kerosene	548,650	623,266	567,823	645,047
Solar oil	150,183	170,608	164,095	186,412
Heavy			288,022	327,193
Lubricating			91,804	104,289
Volatile			15,961	18,132
Total	698,833	793,874	1,127,705	1,281,073

Production of petroleum in Japan and Formosa in 1906–1909.

Year.	Japan.		Formosa.		Total.	
	Koku.	*Barrels.*	*Koku.*	*Barrels.*	*Koku.*	*Barrels.*
1906	1,501,563	1,705,776	4,394	4,992	1,505,957	1,710,768
1907	1,755,464	1,994,207	[a] 14,465	16,432	1,769,929	2,010,639
1908	1,815,001	2,061,841	[a] 8,000	9,088	1,823,001	2,070,929
1909	1,654,526	1,879,542	[a] 116,961	132,867	1,771,487	2,012,409

[a] Estimated.

Production of refined kerosene in Japan and Formosa in 1906–1908.

Year.	Japan.		Formosa.		Total.	
	Koku.	*Barrels.*	*Koku.*	*Barrels.*	*Koku.*	*Barrels.*
1906	582,138	661,309	[a] 3,515	3,993	585,653	665,302
1907	655,420	744,557	[a] 11,572	13,146	666,992	757,703
1908	698,833	793,874	[a] 16,986	19,296	715,819	813,170

[a] Estimated.

During 1909 Mr. K. Kobayashi, of the Hoden Oil Company, published [a] results of a very complete examination of various Japanese petroleums which show it to consist largely of naphthenes, like Russian oils. Several of the oils contain sulphur in about the proportion of the oils of our Gulf coast and in general are similar to these oils.

DUTCH EAST INDIES.

In the following table is given the production of petroleum in the Dutch East Indies during the years 1900 to 1909, inclusive:

Production of petroleum in Dutch East Indies, 1900–1909.

Year.	Borneo.		Java.		Sumatra.		Total.		
	Metric tons.	Liters.	Metric tons.	Liters.	Metric tons.	Liters.	Metric tons.	Liters.	Barrels.
1900	59,352	65,758,263	83,867	97,308,800	[a]158,467	[a] 195,182,667	301,686	358,249,730	2,253,355
1901	85,554	94,788,288	88,597	102,797,300	[a]357,665	[a] 440,534,166	531,816	638,119,754	4,013,710
1902	84,232	93,323,718	54,455	63,182,955	186,655	229,900,893	325,342	386,407,566	2,430,465
1903	105,102	116,446,337	91,568	106,244,811	563,988	694,661,269	760,658	917,352,417	5,770,056
1904	215,109	238,327,180	110,053	127,692,388	542,936	668,731,900	868,098	1,034,751,468	6,508,485
1905	439,487	486,924,000	110,711	128,456,000	513,630	632,635,700	1,063,828	1,248,015,700	7,849,896
1906	387,455	429,275,398	111,378	129,229,083	602,501	742,097,300	1,101,334	1,300,601,781	8,180,657
1907	489,151	541,948,068	142,983	165,900,000	713,841	879,235,063	1,345,975	1,587,083,131	9,982,597
1908	511,049	566,209,890	137,013	158,974,000	738,588	909,715,827	1,386,650	1,634,899,717	10,283,357
1909	411,506	455,922,397	140,351	162,846,428	922,894	1,136,720,015	1,474,751	1,755,488,840	11,041,852

[a] Estimated.

1 gallon Borneo crude=7.5322 pounds.
1 gallon Java crude=7.1924 pounds.
1 gallon Sumatra crude=6.7754 pounds.
1 United States barrel=158.985 liters; 1 liter=1.0567 quarts.

PHILIPPINE ISLANDS.

Mr. W. B. Smith, chief of the division of geology and mines in the Bureau of Science, Philippine Islands, has recently described the various occurrences of petroleum and natural gas. He calls attention to 3 in Tayabas Province, 1 on the west coast of Cebu near Toledo, halfway the length of the island, and 1 near the pueblo of Alequa

[a] Petroleum Review, London, 1909.

near the southern extremity of Cebu. No development has been made in this last locality, but some prospecting has been done in the other localities. The oil is found in bluish shale, presumable Tertiary.

An analysis of oil from Tayabas Province is given below.

Analysis of petroleum from the east coast of Tayabas Province, Philippine Islands; well 120 feet deep.

Specific gravity of crude	0.8318
Baumè gravity	38.3
Color	Claret.
Odor	Aromatic.
Begins to boil, °C	100
Gasoline (to 150° C.), per cent	18.0
Specific gravity	.7698
Kerosene (150° to 300° C.), per cent	58.0
Specific gravity	.8304
Residuum, per cent	23.5
Specific gravity	.9498
Paraffin wax, per cent	4.31
Unsaturated hydrocarbons in crude oil, per cent	15.2

PROSPECTING IN FOREIGN COUNTRIES.

In spite of the great production, unabated interest is shown in developing petroleum indications even in unreasonably remote parts of the world, as in Madagascar, and in the Malay Peninsular. In Algiers the slow development continues of the long-known oil indications, and drilling still proceeds in Nigeria.

SOUTH AFRICA.

During the year 1909 there was vigorous exploitation of many seepages of oil and gas in the Orange River country. No production has resulted, but much experience has been gained, especially in the neighborhood of Ladysmith. The oil and gas occur in shales, especially near igneous dikes, which are very common.

EGYPT.

In April, 1909, the Egyptian Oil Trust (Limited) drilled in a well at 1,287 feet in cavernous dolomitic limestone at Gebel Gemsah, on the Red Sea, 150 miles from Suez. The well was first reported as making 70 barrels, and later 350 barrels a day. No. 3 brought in at 1,640 feet near the end of the year seems as good, and three others are in progress. The oil is said to be like Lima (Ohio) oil, but the percentage of sulphur has not been given.

PERSIA.

The New Anglo-Persian Oil Company has shown great activity during 1909, and oil-bearing strata were struck in 2 wells, 1 near Awaz in the south, the other on Diala River in Kurdestan. The concessions of the company cover a large part of Persia and the producing formations are supposed to extend into Turkey. A pipe line has been commenced from the wells near Awaz to Mohammereh, where a refinery is projected. A report by Mr. Frederick Simpich, consul at Bagdad, containing a map of the oil concessions, is available in the Bureau of Manufactures, Washington, D. C.

WORLD'S PRODUCTION.

World's production of crude petroleum, 1905–1909, by countries.

[Barrels of 42 gallons.]

Country.	1905	1906	1907	1908	1909			
					Rank.	Barrels.	Metric tons.	Per cent of total production.
United States	134,717,580	126,493,936	166,095,335	178,527,355	1	182,134,274	24,284,570	61.24
Russia	54,960,270	58,897,311	61,850,734	62,186,447	2	65,970,350	8,796,047	22.19
Galicia	5,765,317	5,467,967	8,455,841	12,612,295	3	14,932,799	2,076,740	5.02
Dutch East Indies	7,849,896	8,180,657	9,982,597	10,283,357	4	11,041,852	1,474,751	3.71
Roumania	4,420,987	6,378,184	8,118,207	8,252,157	5	9,321,138	1,296,403	3.13
India	4,137,098	4,015,803	4,344,162	5,047,038	6	6,676,517	890,202	2.24
Mexico			1,000,000	3,481,410	7	2,488,742	331,832	.84
Japan [a]	1,472,804	1,710,768	2,010,639	2,070,929	8	2,012,409	268,321	.68
Peru	447,880	536,294	756,226	1,011,180	9	1,316,118	175,482	.44
Germany	560,963	578,610	756,631	1,009,278	10	1,018,837	143,244	.34
Canada	634,095	569,753	788,872	527,987	11	420,755	56,101	.14
Italy	44,027	53,577	59,875	50,966	12	[b] 50,000	[b] 6,954	.03
Other	[b] 30,000	[b] 30,000	[b] 30,000	[b] 30,000	13	[b] 30,000	[b] 4,000	
Total	215,040,917	212,912,860	264,249,119	285,090,399		297,413,791	39,804,647	100.00

[a] Including Formosa, except in 1905. [b] Estimated.

ANALYSES OF CRUDE PETROLEUM FROM VARIOUS STATES.

For about two years a systematic collection of specimens of domestic crude oil has been in progress. These specimens are usually collected by an expert of the United States Geological Survey or by a representative of the corresponding State organization for systematic examination by the same methods of analysis in order that the composition of the petroleum in one field may be compared with that in another. The analyses for Illinois, Oklahoma, and Kansas have already been published. The following series of analyses, collected chiefly in cooperation with the state geologists of the States mentioned, include a few additional pools in Illinois, the principal pools in Kentucky, Ohio, Texas, and West Virginia, with incidental analyses from New Mexico, Utah, and Louisiana. The methods of analysis are explained on page 494 of Bulletin 381 of the United States Geological Survey.[a] These methods are those proposed for international adoption at the Bucarest International Petroleum Congress and are tentatively accepted pending the adoption of various modifications now under consideration by the International Commission for unifying petroleum-testing methods. Least satisfactory in the methods presented are those for the determination of paraffin, asphalt, and unsaturated hydrocarbons. Where the results of distillation are low, this has been shown to be due to the loss of very volatile hydrocarbons even when condensed with the aid of a freezing mixture. Accuracy greater than 1 per cent can not be claimed for these methods. The results, however, give interesting comparisons, and the variation is so great between different oils as to give cause for further investigation as to the reasons for these variations.

[a] Day, D. T., Analysis of crude petroleum from Oklahoma and Kansas; Contributions to Economic Geology, 1908, Pt. II: Mineral Fuels: Bull. U. S. Geol. Survey No. 381, 1910, p. 494.

Analyses of petroleum from various

Serial No.	Location of well.	Collected by—	Collected from—	Number of well.	Depth of well (feet	Physical properties. Gravity at 60° F. Specific.	Baumé.
	KENTUCKY.						
	Allen County.						
6	Petroleum pool, Newman farm, Southern Oil & Gas Co., Petroleum.	Cass Burrus for M. J. Munn.	Well	....	810	0.8490	34.9
	Bath County.						
2	Ragland pool, Ragland sand, Ragland farm, J. W. Radcliffe.	J. W. Radcliffe for M. J. Munn.	Well	....	366	.8963	26.2
	Morgan County.						
11	First Cow Run sand, Buck Run field, Union Township, sec. 11, Harrison farm.	M. W. Crouch	Tank	....	....	.8092	43.0
	Wayne County.						
3	Parnell pool, Sunnybrook sand, Polly Lair farm, P. M. Burwald, Monticello.	M. W. Crouch	Well	1	692	.8083	43.2
4	Sinking pool, Beaver Creek sand, Wood Oil Co., Monticello.	M. J. Munn	do	a 1	600	.8154	41.7
5	Oil Valley pool, Beaver Creek sand, Ohio & Kentucky Oil Refining Co., Oil Valley.	do	do	b 4	690	.8154	41.7
7	Johnson Fork field	do	do	....	....	.8408	36.5
8	....	do	do	....	....	.8235	40.0
9	Cooper pool, Beaver Creek sand, B. S. Huffaker farm, Penn Lubricating Co., Monticello.	M. W. Crouch	do	5	....	.8178	41.2
10	Turkey Rock pool, Slickford district, Jos. Brown & Co., Slickford.	M. J. Munn	do	c 4	....	.8163	41.5
12	Rocky Branch pool (near Monticello), Grant Roberts farm. Dempsey Oil Co., Bradford, Pa., first oil from well.	M. W. Crouch	do	2	187	.9021	25.2
13	Parmleysville pool (north end), Beaver Creek sand, James Burnett farm, Ross Wetzel & Co., Parmleysville.	M. J. Munn	do	3	....	.8348	37.7
	COLORADO.						
	Mesa County.						
1	Debeque	D. T. Day	Well	....	150	.8345	37.75
2	Three-fourths mile northwest of Debeque.	E. B. Woodruff	do	1	....	.8997	25.6
	ILLINOIS.						
	Lawrence County.						
56	Bridgeport Township, Green oil sand, L. C. Cummings farm, Indian Refining Co., Lawrenceville.	Indian Refining Co.	Well	....	1,700	.8289	38.9
55	Petty Township, Green oil sand, Geo. Cooper farm, Indian Refining Co., Lawrenceville.	do	do	....	1,700	.8475	35.2

a Crisman No. 1. b Ingram No. 1. c Z. W. Morris No. 4.

parts of the United States.

Physical properties.		Distillation by Engler's method.													Unsaturated hydrocarbons (per cent).	
			By volume.													
			To 150° C.		150°–300° C.		Residuum.		Total.							
Color.	Odor.	Begins to boil at ° C.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Sulphur (per cent).	Paraffin (per cent).	Asphalt (per cent).	Water (per cent).	Crude.	150°–300°.
Brown	Like Pa. oil.	71	12.5	0.7373	41.0	0.8144	45.3	0.9162	98.8	....	3.65	2.10	Trace.	18.8	7.0
do	do	136	1.0	......	29.0	.8151	69.6	.9434	99.6	....	2.13	0	Trace.	30.0	5.0
Dark green	do	95	13.0	.7270	35.0	.7796	50.7	.8557	98.7	....	5.40	0	....	8.4	6.8
Light green	do	43	27.0	.7047	33.0	.8017	37.3	.9061	97.3	....	2.47	0	....	14.8	6.0
Dark green	do	65	22.0	.7273	36.0	.8043	38.6	.9038	96.6	....	3.73	.56	....	11.6	2.0
....	do	50	20.0	.7129	36.0	.7989	39.7	.9121	95.7	....	3.34	1.78	....	14.8	2.0
Brown	do	53	13.5	.7201	32.0	.7980	49.9	.9235	95.4	....	3.01	2.66	....	31.2	4.0
Dark green	do	60	16.5	.7187	32.0	.7934	46.9	.9056	95.4	....	4.57	0	....	18.8	7.0
Black	do	35	25.0	.7155	29.0	.8062	42.1	.9186	96.1	....	2.65	.80	....	14.4	14.0
Dark green	do	60	23.0	.7181	36.0	.7947	40.2	.9038	99.2	....	2.31	.36	....	15.6	14.0
Black	do	170	....	......	26.0	.8183	73.0	.9259	99.0	....	5.49	.....	Trace.	63.0	3.0
Dark green	do	76	13.0	.7174	36.0	.7959	47.9	.9115	96.9	....	5.09	.....	Trace.	2.0	5.0
Yellow	Aromatic	145	1.0	......	42.0	.7188	56.5	.8427	93.5	....	19.65	.....	....	12.4	4.0
Greenish brown.	do	225	....	......	27.0	.7471	70.9	.8511	97.9	....	27.23	.....	....	......	....
Dark green	Sulphur	73	12.0	.7230	35.0	.7874	49.2	.9067	96.2	....	4.31	.....	Trace.	......	....
do	do	110	6.0	.7480	40.0	.7944	54.2	.9021	100.2	....	1.96	.....	Trace.	......	....

Analyses of petroleum from various

Serial No.	Location of well.	Collected by—	Collected from—	Number of well.	Depth of well (feet).	Physical properties. Gravity at 60° F. Specific.	Baumé.
	ILLINOIS—continued.						
	Lawrence County—Continued.						
54	Lawrence Township, Green oil sand, R. M. Kirkwood farm, Indian Refining Co., Lawrenceville.	Indian Refining Co...	Well..	....	1,700	0.8378	37.1
	Clark County.						
57	Casey Township, K. and E. Young well, Ohio Oil Co., Casey.	Ohio Oil Co...........	Well..	79	2,450	.8299	38.7
	LOUISIANA.						
	Caddo Parish.						
15	Brown Oil Co., Black Bayou.......	Brown Oil Co.........	Well..	1	2,300+	.9109	23.7
	NEW MEXICO.						
	Eddy County.						
1	Two miles east of Dayton, 10 miles southeast of Artesia; owned by W. S. Williams.	W. M. Dougherty.....	Artesian well.	....	1,000	.8951	26.4
2	Three miles south of Dayton; A. F. Lucas, Washington, D. C.	A. F. Lucas...........	Well..	....	914	.9186	22.4
3	Dayton pool; Roswell Oil Co., Artesia.	G. E. Morgan (manager Producers Oil Co.).	...do ..	*a*1	914	.9168	22.7
4	Dayton pool; Roswell Oil Co., Artesia.	David T. Day..........	...do ..	*a*1	914	.9109	23.7
	OHIO.						
	Fairfield County.						
19	Bremen pool, Rush Creek Township; Clinton sand; L. Groves farm.	J. A. Bownocker......	Well..	....	2,462	.7848	48.4
21	Pleasantville pool, Richland Township; Clinton sand; J. G. Ruff farm.	.... do.................	...do...	....	2,345+	.8046	44.0
	Knox County.						
24	Bladenburg pool, Jackson Township; McKee well, Clinton sand.	.....do..................	...do...	....	2,771	.8469	35.3
	Monroe County.						
3	Decker pool (near Lewisville), Summit Township, sec. 23; Big Injun sand; Minard Run Oil Co., Bradford, Pa.; C. B. Buchanan lease.	M. W. Crouch..........	...do...	1	1,500	.7955	46.0
5	Decker pool (near Lewisville), Summit Township, sec. 23; Keener sand; Henry Dillar farm; W. G. Decker, Washington, Pa.	.....do..................	...do...	4	1,400	.7982	45.4
15	Near (250 feet) Ohio No. 5; Big Injun sand; Henry Dillar farm; W. G. Decker, Washington, Pa.	.....do..................	...do...	2	1,480	.7977	45.5

a Hammond.

parts of the United States—Continued.

Physical properties.		Distillation by Engler's method.								Sulphur (per cent).	Paraffin (per cent).	Asphalt (per cent).	Water (per cent).	Unsaturated hydrocarbons (per cent).	
			By volume.												
			To 150° C.		150°–300° C.		Residuum.		Total.						
Color.	Odor.	Begins to boil at ° C.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.					Crude.	150°–300°.
Dark green..	Sulphur...	90	13.0	0.7305	32.0	0.7844	51.9	0.9044	96.9	....	3.30	.....	Trace.	(b)	(b)
.....do.......	...do......	85	8.0	.7222	33.0	.7833	56.1	.8861	97.1	....	.....	.....	....	(b)	(b)
Brown.......	....	248	....	......	10.5	.8690	88.2	.9235	98.7	....	.....	.....	....	(b)	(b)
Black........	...do......	217	....	......	30.0	.8395	68.9	.9241	98.9	(b)	.....	0.56	....	(b)	(b)
.....do.......	...do......	137	Tr.	......	28.5	.8564	68.4	.9444	96.9	(b)	0	0	....	20.0	6.0
.....do.......	...do......	188	....	......	28.0	.8541	72.0	.9395	100.0	(b)	0	3.65	....	28.4	12.0
.....do.......	...do......	142	1.0	......	31.0	.8417	68.1	.9390	100.1	(b)	0	3.91	....	25.6	14.0
Medium green	Like Pa. oil.	68	15.0	.7036	40.0	.7698	42.0	.8557	97.0	....	8.33	0	None..	11.6	4.0
Dark green...	...do......	96	10.0	.7195	43.0	.7751	45.8	.8647	98.8	....	5.36	0	...do...	10.0	4.0
.....do.......	...do......	75	14.0	.7201	26.0	.7973	52.1	.9063	92.1	....	4.17	0	Much .	19.6	7.0
Light green..	...do......	77	18.0	.7175	38.0	.7787	42.4	.8653	98.4	....	2.82	0	...do...	3.2	3.0
Dark amber..	...do......	87	16.0	.7225	39.0	.7758	44.9	.8563	99.9	....	5.47	0	...do...	2.8	3.0
Medium green	...do......	97	11.0	.8255	43.0	.7896	44.1	.8531	98.1	....	2.23	0	...do...	.....	8.0

[b] Not determined.

Analyses of petroleum from various

Serial No.	Location of well.	Collected by—	Collected from—	Number of well.	Depth of well (feet).	Physical properties. Gravity at 60° F. Specific.	Baumé.
	OHIO—continued.						
	Monroe County—Continued.						
6	Jerusalem pool, Malaga Township; Keener sand; Unity Oil Co., Woodsfield; Ernest Harper lease.	M. W. Crouch	Well	1		0.8373	37.2
14	Jerusalem pool, Sunsbury Township; Lime sand; W. R. Gatchell lease; Central Gas Co., Woodsfield.	do	do	1	1,200	.7848	48.4
2	Clarington pool, Salem Township; Lime and Keener sands; Sterling farm, 2 miles north of Clarington; Consolidated Oil and Gas Co., Pittsburg.	do	do	4	1,504	.7968	45.7
4	Graysville pool, Washington Township; Keener sand; Scarbraugh farm; Pure Oil Co., Woodsfield.	do	do	4		.7782	49.9
12	Olive Township; C. W. Brown farm.	C. W. Brown, for M. J. Munn.	do	1		.8260	39.5
16	Griffith pool, Center Township; Keener sand; Markle heirs farm; Pure Oil Co., Woodsfield.	M. W. Crouch	do	2		.7937	46.4
18	Bethel Township, sec. 7; First Cow Run sand; Weber farm; Carter Oil Co., Sisterville, W. Va.	do	do			.7739	50.9
	Morgan County.						
13	Milner pool; First Cow Run sand; J. W. Calvert farm.	do	do	1	325	.8046	44.0
17	Milner pool; Peeker sand; Milner farm.	do	do			.8023	44.5
	Noble County.						
1	Macksburg field, Jefferson Township; Macksburg 500-foot sand; Geo. Rue farm.	do	do	3	516	.8154	41.7
11	Macksburg field, Jefferson Township; Berea sand; Geo. Rue farm.	do	do	2	1,470	.8159	41.6
7	Belle Valley pool, Noble Township; Keener sand; Harry Barnhouse lease; Chris McKee, Belle Valley.	do	do	7	1,465	.8240	39.9
	Perry County.						
10	San Toy pool, Bearfield Township; Berea sand; McCarty farm; Chapman lease.	do	do	3	1,260	.8240	39.9
22	Crooksville pool, Harrison Township; Clinton sand; Ohio Fuel Co. lot.	J. A. Bownocker	do		3,407	.8014	44.7
23	New Straitsville pool, Coal Township; Clinton sand; Clancy lot.	do	do		3,106	.7923	46.7
	Vinton County.						
20	Clinton sand, Jackson township, Clinton farm.	J. A. Bownocker	do		2,480	.7959	45.9

parts of the United States—Continued.

Physical properties.		Distillation by Engler's method.													Unsaturated hydrocarbons (per cent).	
			By volume.													
			To 150° C.		150°–300° C.		Residuum.		Total.							
Color.	Odor.	Begins to boil at ° C.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Sulphur (per cent).	Paraffin (per cent).	Asphalt (per cent).	Water (per cent).	Crude.	150°–300°.
Dark amber..	Like Pa. oil.	100	5.0	0.7815	30.0	0.8195	63.6	0.8589	98.6	....	5.65	.....	Trace.	24.0	5.0
Medium amber.	...do.......	55	19.0	.6837	35.5	.7696	43.1	.8568	97.6	....	3.60	0	....	6.8	4.0
.....do........	...do.......	90	15.0	.7210	40.0	.7771	43.7	.8578	98.7	....	5.65	0	....	4.0	4.0
Amber........	...do.......	70	25.0	.7020	38.0	.7715	36.7	.8526	99.7	....	3.35	0	....	6.0	2.0
Dark amber..	...do.......	67	12.0	.7290	33.0	.7934	53.5	.8663	98.5	....	11.24	0	....	22.8	5.0
Light amber .	...do.......	75	18.5	.7232	42.0	.7893	39.3	.8537	99.8	....	3.56	0	....	5.6	5.0
Dark amber..	...do.......	65	19.0	.7034	51.0	.7721	28.5	.8521	98.5	....	2.91	0	....	4.8	5.0
Dark green...	...do.......	74	14.5	.7137	38.5	.7815	43.6	.8669	96.6	....	5.36	0	....	11.6	5.0
.....do........	...do.......	70	19.0	.7141	37.0	.7834	43.2	.8623	99.2	....	5.74	0	....	4.4	5.0
.....do........	...do.......	115	5.0	.7435	43.0	.7801	50.0	.8626	98.0	....	6.15	0	....	3.6	3.0
.....do........	...do.......	62	15.0	.7215	30.0	.7908	51.3	.8783	96.3	....	4.86	0	....	6.0	2.0
.....do........	...do.......	57	13.0	.7250	28.0	.7463	55.8	.8805	96.8	....	5.44	0	....	3.2	4.0
.....do........	...do.......	60	18.0	.7230	27.0	.7981	52.2	.8917	97.2	....	6.16	0	Trace.	8.0	5.0
Light amber .	...do.......	98	7.0	.7215	45.0	.7736	45.6	.8663	97.6	....	6.63	0	....	10.0	4.0
(?)	...do.......	80	17.5	.7141	33.0	.7753	45.7	.8706	96.2	....	8.30	0	....	10.8	6.0
Medium green	Like Ohio oil.	102	4.0	.7140	51.0	.7673	43.6	.8600	98.0	....	5.62	0	0	5.6	4.0

Analyses of petroleum from various

Serial No.	Location of well.	Collected by—	Collected from—	Number of well.	Depth of well (feet).	Physical properties. Gravity at 60° F. Specific.	Baumé.
	OHIO—continued.						
	Washington County.						
8	Germantown pool, Liberty township. First Cow Run sand. Hendershot lease, Consolidated Oil & Mining Co., saltpeter.	M. W. Crouch	Well	1	827	0.8023	44.5
9	Fifteen pool, Liberty township, Maxton sand.	do	do		1,260	.7865	48.0
	TEXAS.						
	Hardin County.						
4	Sour Lake pool, Beatty sand, township 75, Cannon tract, O. T. Taber, Sour Lake.	O. T. Taber	Well	3	1,310	.9067	24.4
5	Sour Lake pool, Taber Oil Co., Sour Lake	David T. Day	do	a 1	1,780	.9272	21.0
5a	Sour Lake pool, Rodger's tract, township 81, Taber Oil Co., Sour Lake.	O. T. Taber	do	1		.9421	18.6
6	Sour Lake pool, Graham and Gore, Sour Lake.	David T. Day	do	3	1,745	.9144	23.1
9	Sour Lake pool, Sun Co., Beaumont.	do	do	2	1,020	.9352	19.7
10	Sour Lake pool, Minor Oil Co. (Caprock oil from Shoestring).	do	do	23	1,100	.9026	25.1
7	Saratoga pool, Rio Bravo Oil Co., Houston.	do	do	220	994	.9472	17.8
8	do	do	do	265	1,377	.9217	21.9
	Harris County.						
15	Humble pool, W. S. Farish, Houston (Caprock oil).	David T. Day	Well		1,174	.9198	22.2
16	Humble pool, Patrick Bros., Humble; shallow well.	do	do		900	.9340	19.9
	Jefferson County.						
2	Spindletop pool, L. P. Hammond & Co., Chicago, Ill.	David T. Day	Well	b 1	1,130	.9085	24.1
3	Spindletop pool, Wilson-Broach Co., Beaumont.	do	do	c 3	815	.9126	23.4
	Marion County.						
1	Caddo (La.) pool, J. M. Guffey Co., Beaumont.	David T. Day	Well	d 1	±2,300	.8065	43.6
	Navarro County.						
11	Powell pool, H. G. Johnston, Corsicana; Stout lease.	H. G. Johnston	Well	7	815	.9121	23.5
12	Corsicana pool, Staley & Barnsdall, Corsicana.	David T. Day	do	13	{ 1,000 / 1,100 }	.8500	34.7
	Reeves County.						
13	Ross pool (near Toyah); Leatherman well.	David T. Day	Well	1	265	.9079	24.2

a Taber No. 1. b Chicago No. 1. c Vivian No. 3. d Burr No. 1.

parts of the United States—Continued.

Physical properties.		Distillation by Engler's method.												Unsaturated hydrocarbons (per cent).	
			By volume.												
			To 150° C.		150°–300° C.		Residuum.		Total.						
Color.	Odor.	Begins to boil at ° C.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Sulphur (per cent).	Paraffin (per cent).	Asphalt (per cent).	Water (per cent).	Crude.	150°–300°.
Medium green	Like Pa. oil.	65	16.0	0.7175	35.0	0.7797	45.4	0.8679	96.4	....	6.43	0	....	6.0	2.0
Dark amber..	...do......	60	20.0	.6970	37.0	.7716	42.1	.8537	99.1	....	7.25	0	....	12.4	2.0
Dark green...	Sulphur...	95	3.0	......	31.0	.8597	65.9	.9440	99.9	....	0	0	Trace.	31.2	11.0
Black.........	...do......	185	....	......	20.0	.8721	79.4	.9409	99.4	....	0	.40	Trace.	46.0	9.0
.....do........	...do......	187	....	......	19.0	.8761	80.4	.9472	99.4	....	0	.57	Trace.	36.4	9.0
.....do........	...do......	95	1.0	......	25.0	.8377	72.0	.9377	98.0	....	0	0	Trace.	31.2	11.0
Dark green...	...do......	170	....	......	23.0	.8750	76.7	.9569	99.7	....	0	0	....	59.6	11.0
Black.........	...do......	96	2.0	......	32.0	.8401	65.4	.9409	99.4	....	0	.55	....	22.8	5.0
.....do........	...do	212	....	......	18.0	.8856	81.1	.9615	99.1	....	0	.74	Trace.	66.8	9.0
.....do........	...do	175	....	......	28.0	.8661	72.0	.9504	100.0	....	0	.59	Trace.	36.4	9.0
Black.........	Sulphur...	118	.5	......	40.0	.8646	58.3	.9615	98.8	....	0	3.17	Trace.	26.4	5.0
Dark green...	...do......	223	....	......	18.0	.8938	81.1	.9321	99.1	....	0	.....	....	32.4	3.0
Dark green...	Sulphur...	135	.5	......	37.0	.8611	62.3	.9396	99.8	....	0	0	Trace.	22.8	8.0
.....do........	...do......	153	....	......	33.5	.8699	65.7	.9434	99.2	....	0	0	....	25.2	6.0
Brown.......	Pa. oil....	100	6.0	.7305	50.5	.7646	42.9	.8739	99.4	....	7.02	.....	....	12.8	5.0
Black........	Aromatic .	168	....	......	19.5	.8571	80.1	.9296	99.6	....	0	0	....	31.6	5.0
.....do........	...do......	138	1.0	......	46.0	.7934	51.4	.9056	98.4	....	3.96	.38	Trace.	15.2	3.0
Dark green...	H_2S.......	172	....	......	23.0	.8449	76.7	.9302	99.7	....	0	0	....	28.4	6.0

Analyses of petroleum from various

Serial No.	Location of well.	Collected by—	Collected from—	Number of well.	Depth of well (feet).	Physical properties. Gravity at 60° F. Specific.	Baumé.
	TEXAS—continued.						
	Reeves County—Continued.						
14	Ross pool (near Toyah); east of Leatherman well; Producers Oil Co., Houston.	David T. Day	Well	1	......	0.8658	31.7
	UTAH.						
	San Juan County.						
1	....	M. R. Campbell	......	......	......	.8755	29.9
3	Goodridge townsite, E. L. Goodridge, Goodridge.	E. L. Goodridge	Well	1	225	.8363	37.4
4	....do	....do	...do	4	263	.8264	39.4
	Uinta County.						
2	Whiskey Run (near Dragon), Tunnel Mining Co., Dragon.	David T. Day	Tunnel	......	......	.9511	17.2
	WEST VIRGINIA.						
	Doddridge County.						
55	Eagles Mills; Big Injun sand; Chas. Stewart.	M. J. Munn	Well	8	......	.7941	46.3
60	One mile south of Eagles Mills; Big Injun sand; Chas. Stewart.	....do	...do	16	......	.7756	50.5
59	Sullivan pool, 1 mile west Center Point, McElroy Creek; Laura Sweeney lease; South Penn Oil Co., Oil City, Pa.	....do	...do	2	......	.7874	47.8
58	Morgansville pool, First Cow Run sand; J. W. Allen lease; H. E. Donohue, Morgansville.	....do	...do	1	......	.8014	44.7
	Harrison County.						
61	Shinnston pool, Clay district; Fifty-foot sand; E. J. Whiteman lease; South Penn Oil Co., Oil City, Pa.	David T. Day	Well	3	2,015	.7977	45.5
	Lewis County.						
57	About 1½ miles southwest of Churchville; M. A. Egan lease; South Penn Oil Co., Oil City, Pa.	M. J. Munn	Well	1	......	.8240	39.9
53	Gantz sand; McDonald lease	....do	...do	6	......	.8235	40.0
	Pleasants County.						
12	Horseneck sand, Boyd heirs farm; Horseneck.	G. P. Grimsley	Well	......	280	.8149	41.8
13	Maxton sand, Jefferson Township; French Creek Oil Co., Marietta, Ohio; Smith's well.	....do	...do	......	......	.8173	41.3
14	Maxton sand, Jefferson Township; French Creek Oil Co., Marietta, Ohio; Amber well.	....do	...do	......	......	.7923	46.7

parts of the United States—Continued.

Physical properties.		Distillation by Engler's method.													Unsaturated hydrocarbons (per cent).	
			By volume.													
			To 150° C.		150°–300° C.		Residuum.		Total.							
Color.	Odor.	Begins to boil at ° C.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Sulphur (per cent).	Paraffin (per cent).	Asphalt (per cent).	Water (per cent).		Crude.	150°–300°.
Dark green...	H_2S.......	128	6.0	0.7710	36.0	0.8176	57.9	0.9115	99.9	....	0	0	....		18.8	6.0
Black........	....	212	....	......	29.0	.8283	71.5	.9035	100.5	....	5.77	3.32	....		21.2	6.0
.....do.......	....	90	10.0	.7375	38.0	.7967	51.6	.8974	99.6	....	7.31	.....	Trace.		.....	....
.....do.......	....	70	12.0	.7245	36.0	.7941	49.3	.8974	97.3	....	6.09	.....	Trace.		.....	....
Brown.......	Aromatic .	250	....	......	28.0	.9135	70.0	.9804	98.0	....	.....	.....	Trace.		.....	....
Dark green...	Like Pa. oil.	53	16.0	.7078	40.0	.7797	41.6	.8679	97.6	....	5.10	0	0		10.8	5.0
Medium green	...do.......	63	20.0	.7018	38.0	.7778	36.0	.8552	*a*94.0	....	6.30	0	0		13.2	5.0
Dark amber..	...do.......	55	19.0	.7146	40.0	.7810	37.9	.8589	96.9	....	6.02	0	0		16.0	4.0
Medium grecn	...do.......	58	16.0	.7162	38.0	.7868	41.2	.8674	95.2	....	5.19	0	0		16.8	4.0
Medium amber.	Like Pa. oil.	72	14.0	.7104	40.0	.7777	44.1	.8505	98.1	....	9.73	0	0		12.8	4.0
Light green..	Like Pa. oil.	120	3.5	.7435	41.0	.7846	55.3	.8679	99.8	....	6.77	0	0		14.4	5.0
Black........	...do.......	80	9.5	.7260	36.0	.7865	53.8	.8739	99.3	....	7.10	0	0		18.8	5.0
Medium green	Like Pa. oil.	99	17.0	.7400	35.0	.7899	47.9	.8642	99.9	....	6.95	0	0		4.0	4.0
Light green..	...do.......	140	.7	......	48.0	.7798	50.8	.8573	99.5	....	7.72	0	0		6.0	1.0
Medium green	...do.......	80	22.0	.7175	36.0	.7780	40.5	.8560	98.5	....	4.87	0	0		7.6	3.0

a Low because of very volatile hydrocarbons.

Analyses of petroleum from various

Serial No.	Location of well.	Collected by—	Collected from—	Number of well.	Depth of well (feet).	Physical properties. Gravity at 60° F. Specific.	Baumé.
	WEST VIRGINIA—continued.						
	Pleasants County—continued.						
15	First Cow Run sand, McKim Township; S. Y. Ramage Oil Co., Oil City, Pa.	G. P. Grimsley			994	0.8135	42.1
16	First Cow Run sand, Spindle Top; Schultz Farm Oil Co., St. Marys.	do	do		1,040	.7896	47.3
17	Big Injun sand, Sugar Valley; Sherlock and Toronski, Canton, Ohio.	do	do		1,443	.7861	48.1
18	First Cow Run sand, Sugar Valley; Sherlock and Toronski, Canton, Ohio.	do	do		635	.7735	51.0
19	Arvilla pool, First Cow Run sand; Heneghan and Handlaw Oil Co., Sisterville.	do	do		615	.7883	47.6
20	Lytton pool, Big Injun sand; South Penn Oil Co., Oil City, Pa.	do	do			.7726	51.2
	Ritchie County.						
29	Grant Township, Salt sand; Cairo Oil Co., Cairo; Moats (Cairo) pool.	G. P. Grimsley	Well		1,717	.8895	27.4
30	Grant Township, Keener sand; Cairo Oil Co., Cairo; Moats (Cairo) pool.	do	do		1,842	.8102	42.8
31	Grant Township, Salt sand; Cairo Oil Co., Cairo; Davidson (Cairo) pool.	do	do		1,538	.8102	42.8
32	Oil Ridge pool, Grant Township; Salt sand; R. G. Gillespie Oil Co., Pittsburg, Pa.	do	do			.8000	45.0
33	Elm Run pool, Keener sand; Bunnell Oil Co., Parkersburg.	do	do		2,145	.8000	45.0
34	Volcano pool, Grant Township; Heavy oil sand; Mount Farm Oil Co., Volcano.	do	do		600	.8130	42.2
37	Long Run field, Grant Township; Salt sand; Bando Oil Co., Baltimore, Md.	do	do		1,588	.8037	44.2
38	McFarlan pool, Murphy Township; Cairo salt sand; Cairo Oil Co., Cairo.	do	Well		1,494	.8005	44.9
39	do	do	do		1,549	.7705	51.7
40	do	do	do	*a* 1	1,534	.8149	41.8
41	Cairo pool, Grant Township; Big Injun sand; Ellen Hall farm; Cairo Oil Co., Cairo.	do	do	1	1,654	.8154	41.7
42	Cairo pool, Grant Township; Cairo salt sand; Cairo Oil Co., Cairo; Biddie Deem farm.	do	do	2	1,491	.8051	43.9
43	Highland pool, Clay Township; Kenner sand; Carter Oil Co., Sistersville.	do	do			.7865	48.0
44	Whiskey Run pool, Clay Township; Big Injun sand; South Penn Oil Co., Oil City, Pa.	do	do		1,786	.7684	52.2
45	Wolf Pen pool, Grant Township; Keener sand; McBride Oil Co., Pittsburg, Pa.	do	do		1,750	.7874	47.8

a Donaldson No. 1.

parts of the United States—Continued.

Physical properties.		Distillation by Engler's method.												Unsaturated hydrocarbons (per cent).	
			By volume.												
			To 150° C.		150°–300° C.		Residuum.		Total.						
Color.	Odor.	Begins to boil at ° C.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Sulphur (per cent).	Paraffin (per cent).	Asphalt (per cent).	Water (per cent).	Crude.	150°–300°.
Dark green...	Like Pa. oil.	119	4.0	0.7475	49.0	0.7811	46.2	0.8642	99.2	....	6.71	0	0	3.6	5.0
.....do........	...do.......	73	18.0	.7160	39.5	.8003	39.7	.8607	97.2	....	7.25	0	0	4.0	3.0
Light green..	...do.......	92	15.0	.7120	45.0	.7683	38.5	.8511	98.5	....	6.44	0	0	6.4	3.0
Medium green	...do.......	73	19.0	.7040	45.0	.7690	38.0	.8492	102.0	....	5.49	0	0	6.0	4.0
.....do........	...do.......	123	2.0	....	68.0	.7623	29.7	.8413	99.7	....	3.18	0	0	4.0	4.0
Dark amber..	...do.......	68	24.5	.7060	37.0	.7753	34.0	.8549	*a* 95.5	....	4.87	0	0	7.6	4.0
Brown.......	Like Pa. oil.	220	....	......	11.0	.8525	88.7	.8906	99.7	....	4.08	0	0	32.8	7.0
Light green..	...do	118	6.0	.7460	46.0	.7791	48.0	.8547	100.0	....	6.30	0	0	6.0	3.0
Medium green	...do	105	7.5	.7310	45.5	.7781	47.2	.8331	100.2	....	7.84	0	0	7.2	4.0
.....do.........	...do	87	17.0	.7161	39.0	.7780	43.5	.8610	99.5	....	6.36	0	0	7.2	3.0
Medium amber.	...do	93	10.0	.7175	44.0	.7717	44.9	.8610	98.9	....	9.15	0	0	6.4	4.0
Medium green	...do	115	7.0	.7360	43.0	.7762	47.7	.8906	97.7	....	7.17	0	0	7.6	3.0
Dark green...	...do	108	3.0	.7370	49.0	.7659	48.0	.8573	100.0	....	6.92	0	0	8.0	4.0
Dark green...	...do	90	16.0	.7175	39.0	.7773	45.0	.8618	100.0	....	4.22	0	Trace.	8.4	2.0
Light green..	...do.......	65	22.0	.6930	37.0	.8076	35.2	.8516	*b* 94.2	....	5.98	.....	....	6.4	3.0
Medium green	...do.......	130	2.5	.7420	46.0	.7741	51.4	.8565	99.9	....	9.05	0	....	7.6	4.0
Medium amber.	...do.......	137	1.0	......	49.0	.7767	50.1	.8552	100.1	....	8.16	0	Trace.	6.0	3.0
Dark green...	...do.......	90	10.0	.7235	39.5	.7761	48.1	.8610	97.6	....	9.48	0	...do...	6.4	3.0
Light green..	...do.......	79	11.0	.7045	44.0	.7706	41.1	.8513	96.1	....	3.61	0	...do...	6.4	4.0
Medium amber.	...do.......	70	24.0	.7010	37.5	.7711	34.5	.8516	96.0	....	7.37	0	...do...	8.4	4.0
Dark green...	...do.......	92	7.0	.7055	50.0	.7616	40.4	.8587	97.4	....	5.35	0	....	7.2	3.0

[a] Low total because of escape of very volatile hydrocarbons.
[b] Low total because of escape of very volatile hydrocarbons; average of three distillations.

Analyses of petroleum from various

Serial No.	Location of well.	Collected by—	Collected from—	Number of well.	Depth of well (feet).	Physical properties. Gravity at 60° F. Specific.	Baumé.
	WEST VIRGINIA—continued.						
	Ritchie County—Continued.						
46	Wolf Pen pool, Grant Township; Keener sand; Sarber Oil and Gas Co., Parkersburg.	G. P. Grimsley	Well		1,950	0.7804	49.4
47	Harrisville pool, Union Township; Squaw sand; Hartman Oil Co., Pittsburg, Pa.	do	do			.7839	48.6
48	Harrisville pool, Union Township; Big Injun sand; Harrisville Heat and Light Co., Harrisville.	do	do		1,850	.7977	45.5
49	Clay Township; Squaw sand; McKelvey Oil Co., Pittsburg, Pa.	do	do		1,790	.7959	45.9
50	Flanagan pool, Union Township; Keener sand; Carter Oil Co., Sistersville.	do	do			.7986	45.3
51	Inland pool, Union Township; Maxton and Big Injun sand; South Penn Oil Co., Oil City, Pa.	do	do			.7986	45.3
52	Prunty pool, Union Township; Big Injun sand; Carter Oil Co., Sistersville.	do	do			.7701	51.8
56	Cairo pool, Grant Township; J. H. Hatfield, lease; Cairo Oil Co., Cairo.	M. J. Munn	do	2		.8144	41.9
	Tyler County.						
54	Alvy-Gordon sand; J. F. Ingraham. Lot No. 1.	M. J. Munn	Well		2,070	.8078	43.3
	Wood County.						
21	Pohick pool, Williams Township; Macksburg and Maxton sand; Clark & Ritchie Co., Marietta, Ohio.	G. P. Grimsley	do			.8140	42.0
22	Braz pool, Williams Township; First Cow Run sand; Clark & Ritchie Co., Marietta, Ohio.	do	do		634	.7950	46.1
23	Williams Township; First Cow Run sand; Henderson Oil Co., Marietta, Ohio.	do	do		850	.8055	43.8
24	Eppelsin pool, Williams Township; Second Cow Run sand; Mallory Bros. and Stewart, Parkersburg.	do	do		920	.8111	42.6
25	Union Township; Salt sand; McGinnis Oil Co., Williamstown.	do	do		1,215	.8250	39.7
26	Union Township; Second Streak Salt sand; McGinnis Oil Co., Williamstown.	do	do		1,069	.8023	44.5
27	Williams Township, First Cow Run sand; Consolidated Oil Co., Pittsburg.	do	Well		770	.8009	44.8
28	Williams Township, Berea sand; Lydecker Tool Co., Marietta, Ohio.	do	do			.8526	34.2
35	Volcano field, Walker Township, (lubricating oil) heavy oil sand; Volcanic Oil and Gas Co., Parkersburg.	do	do		350	.8750	30.0

parts of the *United States*—Continued.

Physical properties.		Distillation by Engler's method.													Unsaturated hydrocarbons (per cent).	
			By volume.													
			To 150° C.		150°–300° C.		Residuum.		Total.							
Color.	Odor.	Begins to boil at ° C.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Sulphur (per cent).	Paraffin (per cent).	Asphalt (per cent).	Water (per cent).	Crude.	150°–300°.
Light green..	Like Pa. oil.	84	13.5	0.7000	39.0	0.7638	41.8	0.8495	[a]94.3	....	5.00	0	(?)	8.4	4.0
Light amber.	...do.......	71	20.0	.7145	39.0	.7763	38.3	.8537	97.3	....	7.44	0	....	6.8	3.0
Dark amber..	...do.......	93	17.0	.7265	42.0	.7770	40.9	.8485	99.9	....	5.32	0	....	5.6	4.0
Medium amber.	...do.......	103	6.5	.7300	53.0	.7709	40.7	.8485	100.2	....	6.52	0	....	5.6	4.0
Dark green...	...do.......	74	15.0	.7170	41.0	.7804	42.3	.8647	98.3	....	6.33	0	....	7.2	4.0
.....do........	...do.......	75	11.0	.7085	38.5	.7731	45.4	.8618	[a]94.9	....	6.58	0	....	7.6	4.0
.....do........	...do.......	122	3.0	.7440	47.0	.7771	50.5	.8581	100.5	....	8.67	0	....	5.6	4.1
Medium green	...do.......	58	17.0	.7097	36.0	.7846	44.0	.8615	97.0	....	7.30	0	Trace.	.....	6.0
Medium amber.	...do.......	70	14.0	.7163	38.0	.7840	46.7	.8621	98.7	....	6.11	0	....	12.8	5.0
Dark green...	...do	97	10.0	.7190	39.0	.7766	50.3	.8679	99.3	....	5.89	0	Trace.	11.2	3.0
Medium green	...do	73	10.0	.7045	42.0	.7420	44.3	.8658	98.3	....	6.32	0	...do...	10.4	4.0
Brown........	...do	98	13.0	.7245	41.0	.7776	46.2	.8608	100.2	....	5.33	0	...do...	9.2	4.0
Dark green...	...do	110	3.0	.7320	47.0	.7721	47.1	.8679	97.1	....	4.99	0	...do...	3.6	4.0
.....do........	...do	131	3.0	......	44.0	.7766	51.4	.9265	98.4	....	5.61	0	...do...	11.2	4.0
.....do........	...do	70	11.5	.7095	36.5	.7748	47.8	.8676	[b]95.8	....	5.90	0	...do...	12.0	4.0
.....do........	...do.......	87	17.0	.7205	38.0	.7766	44.3	.8615	99.3	....	5.69	0	0	10.4	3.0
.....do........	...do	170	....	......	31.0	.7949	69.1	.8807	100.1	....	8.84	0	0	0	4.0
.....do........	...do	165	....	......	16.0	.8356	82.4	.8872	98.4	....	0	0	Much.	21.6	5.0

[a] Low total because of escape of very volatile hydrocarbons.
[b] Low total because of escape of very volatile hydrocarbons; average of three distillations.

Analyses of petroleum from various

Serial No.	Location of well.	Collected by—	Collected from—	Number of well.	Depth of well (feet).	Physical properties. Gravity at 60° F. Specific.	Baumé.
	WEST VIRGINIA—continued.						
	Wood County—Continued.						
36	Volcano pool, Walker Township, Keener sand, heavy oil sand, Big Injun sand; Volcanic Oil and Gas Co., Parkersburg.	G. P. Grimsley	Well		600	0.8429	36.1
	WYOMING.						
	Fremont County.						
3	Lander field near Dallas, T. 30 N., R. 99 W.	E. G. Woodruff	Well	3	750	.9198	22.2
4	do	do	do	2	400	.9126	23.4
5	do	do	do	10	825	.9121	23.5
6	do	do	do	11	965	.9126	23.4
7	do	do	do	13	697	.9091	24.0
8	Plunkett well (near oil spring), N. ½ NE. ¼ sec. 26, T. 1 S., R. 1 E., Wind River.	do	do		250	.8121	42.4
17	do	do	do		300	.8121	42.4
	Natrona County.						
10	Salt Creek	C. H. Wegemann	Well	[a] 10		.9097	23.9
11	Salt Creek, southeast of Gusher	do	do	Stock.		.8563	33.5
12	Salt Creek	do	do	[b] 12		.9085	24.1
13	Salt Creek, Bothwell Draw	do	do	Iba.		.8314	38.4
14	Salt Creek, Gusher, sample No. 1	do	do			.8221	40.3
15	Salt Creek, Gusher, sample No. 2	do	do			.8255	39.6
16	Salt Creek, Gusher, sample No. 3	do	do			.8221	40.3

[a] Shannon No. 10. [b] Shannon No. 12.

arts of the United States—Continued.

Physical properties.		Distillation by Engler's method.													Unsaturated hydrocarbons (per cent).	
			By volume.													
			To 150° C.		150°–300° C.		Residuum.		Total.							
Color.	Odor.	Begins to boil at ° C.	Cubic centimeters.	Specific gravity.	Cubic centimeters	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Sulphur (per cent).	Paraffin (per cent).	Asphalt (per cent).	Water (per cent).		Crude.	150°–300°.
Dark green...	Like Pa. oil.	123	1.5	......	33.0	0.7954	65.8	0.8663	100.3	....	5.81	0	Much.		14.0	4.0
Dark brown..	....	93	2.5	......	22.0	......	(Flask broke.	Water in oil.)					....		50.4	....
....do........	....	120	2.0	......	23.5	.8041	69.9	.9543	95.4	....	.91	4.02	....		46.4	4.0
....do........	....	93	2.0	......	21.0	.8067	75.2	.9589	98.2	....	1.27	5.69	....		50.8	4.0
....do........	....	105	1.5	......	24.0	.8018	73.9	.9605	99.4	....	.90	11 04	....		58.0	4.0
....do........	....	108	2.5	......	23.0	.8047	73.1	.9589	98.6	....	.62	15.26	....		50.8	9.0
Light green..	Like Pa. oil.	83	13.0	.7183	40.0	.7943	45.9	.8563	98.9	....	4.51	0	....		8.4	5.0
....do........	...do.......	77	14.0	.7244	41.0	.7994	41.1	.8755	96.1	....	5.85	0	....		10.4	5.0
Olive green...	....	204	....	......	12.5	.7673	86.9	.9192	99.4	....	1.14	0	....		15.2	6.0
Dark green...	....	126	1.0	......	36.0	.7854	62.4	.9032	99.4	....	5.63	0	....		13.2	4.0
Green........	....	213	....	......	10.0	.8673	86.6	.9211	96.6	....	0	0	....		14.8	8.0
....do........	....	84	11.0	.7215	34.0	.7875	54.0	.8923	99.0	....	5.56	0	....		13.2	4.0
....do........	....	76	8.0	.7220	38.0	.7881	49.3	.8963	95.3	...	4.97	0	....		16.4	4.0
....do........	....	76	11.0	.7210	36.0	.7934	50.0	.9088	97.0	...	4.91	0	....		13.2	4.0
....do........	....	66	16.0	.7114	29.0	.7911	52.4	.8861	97.4	....	6.44	0	....		14.4	5.0

PEAT.

By Charles A. Davis.

INTRODUCTION.

The preparation and use of peat as fuel has been almost entirely ıeglected in the United States, in spite of the widespread occurrence ınd generally good quality of peat beds in those parts of the country vhere there are no workable coal deposits and where the demand for 'uel for power and heat is large. In New England and some other ılder sections of the country peat was formerly cut from swamps ınd used for domestic fuel; but after coal mining began even this small use was generally abandoned.

Since 1903, however, a considerable and persistent interest has been shown in the possibility of utilizing the great peat deposits of the country, and many attempts, some of them involving the expenditure of large sums of money, have been made to place peat fuel on the markets of the country in commercial quantity.

The more notable and extensive peat-fuel plants have been those adopting the plan of briquetting powdered dry peat, generally without the use of a binder. None of these plants have remained long in operation or produced fuel in commercial quantity, and it has therefore been assumed that the briquetting process was not adapted to peat. With equal or more justice, however, the apparent lack of success of these enterprises might be attributed to the use of inefficient driers or methods of drying, to the inexperience of the operators, to the use of poorly devised briquetting presses and other equipment, to lack of capital to continue what were announced to be experiments only, to lack of transportation facilities, or to other similar factors, any one of which might be just as important as that to which the lack of success was charged.

Less conspicuous, because less widely advertised, and less spectacular have been the small factories started to make "machine," "condensed," or "wet-process" peat fuel. In this method the peat is taken wet as it comes from the bog, which may be drained or not, and is ground into a pulp in a simple grinding machine similar to a brickmaker's pug mill. Such a machine breaks up the woody matter and other coarse remains of plants contained in the peat and shapes the resulting peat pulp into long prisms, which are cut into bricks as they issue from the outlet under comparatively slight pressure. The bricks are received on boards or pallets, on which they are spread out to dry by exposure to the air, being turned as often as necessary while drying. A modification of the process in use in

Europe eliminates the bricking operation, the pulp being dropped from the machine into tram cars and conveyed to a previously leveled part of the bog, where it is spread out into a thin sheet and marked off into rectangular blocks by a special machine. After several days the blocks become separated, and are then turned over, and later, after they are partly dried and hardened, they are stacked.

Plants for making machine peat require a much smaller investment of capital for the same output than the more complicated briquet factories, and the thoroughly air-dried bricks or blocks of machine peat make as good fuel for the same tonnage as the more finely finished briquets.

This method of manufacture is in general use in the peat-producing parts of Europe, where more than 12,000,000 tons of good fuel are made annually by the use of various modifications of this method.

The enterprises started in the United States for using this process have not generally been very productive and several have run for a short season only, after which they have been abandoned. Inquiry has developed the fact, however, that none of these enterprises was efficient for production.

It may be said, therefore, that the failure to produce peat fuel commercially in the United States has been due, not to the nature of the peat itself, but to other things, such as overenthusiasm, lack of understanding of the means of successful commercial production, too little capital, and too much confidence in poorly designed and untried machinery. The fact that there is a market for peat has not been questioned, for the small product offered has always sold readily and at good prices.

Errors in management have been in part a cause of the failure to produce peat fuel. Men without actual working knowledge of the methods of handling peat or of machinery for preparing it have been put in charge of mechanical equipments designed and built as the result of long European experience, and have at the outset assumed that the equipment was all wrong because with an inexperienced working force it could not be made to do what was expected of it, and have, without further trial, condemned or discarded it for types of their own invention.

During the year 1909 only a few small peat-fuel plants were in operation in the United States, and most if not all of them were still in experimental stages of development throughout the season. They were as follows:

The Lexington Peat Company, East Lexington, Mass., a small briquetting plant, made experimental production only; the Saugus Peat Company, Lynnfield, Mass., made a very small output of cut peat; the Massachusetts Peat Fuel Company, Norwood, Mass., producing machine peat, started very late in the season on account of changes in machinery and made no commercial production in 1909.

Two small peat-fuel factories were in operation in Maine in 1909. One, managed by F. H. Fellows, at Lewiston, was making a small commercial output of machine peat; the other was maintained by the Peat Manufacturing Company, of Bangor, at Bucksport, for the purpose of testing an improved method of removing water from peat to hasten its drying for fuel. The fuel made in 1909 was consumed at the plant.

The American Peat Coal Company operated its plant at Pompton Plains, N. J., for a part of the season, making machine peat with a German peat machine. The output, which was small, was sold on contract for a special purpose.

At Bancroft, Mich., P. Heseltine, of Detroit, operated a newly invented machine for macerating peat and produced the largest amount of peat fuel reported by anyone for the year, although the plant was still in an experimental stage of development. A good quality of machine peat was made.

The only other peat-fuel plant that reported any production for 1909 was that of the Fertile Peat and Brick Company, at Fertile, Iowa. This company manufactured machine peat and used part of its output for firing brick kilns and sold the rest at a fair price.

PRODUCTION.

PEAT FUEL.

The total production of peat fuel reported was 1,145 short tons, valued at $4,145, an average price of about $3.61 per ton. The highest price reported was $5 per ton.

PEAT FERTILIZER AND FERTILIZER FILLER.

There were 11 producers of peat for fertilizer uses reported in operation during the year 1909. These were distributed over the country as follows: Florida, 1; New Jersey, 2; New York, 2; Ohio, 1; Pennsylvania, 1; Indiana, 2; Michigan, 1; Illinois, 1.

Two of these, which made a small production in 1908, did not report for 1909, but it was learned that they were not closed.

The total production from the factories reporting their output for the year was 26,768 short tons, valued at $118,891, an average price per ton of $4.44. This was nearly 4,000 tons more than was reported in 1908, but the average price per ton was about 83 cents less. This lower average price is doubtless due to the fact that at some of the plants considerable sun-dried material was sold at prices below the selling price of the "bone-dry" or artificially dried powder. It was generally stated by the producers that the prices received were too low to be satisfactory.

PEAT-MOSS STABLE LITTER.

A single firm in the United States, the John E. Baker Moss Company, of Garrett, Ind., made peat-moss stable litter in 1909. As in former years, the litter was sold in bales weighing about 225 pounds each, and the quantity made is reported as 1,254 short tons, or 11,000 bales. The price received was not quoted, but in 1908 it was $1.25 per bale at the plant for less than carload lots, with a small reduction on large lots.

PEAT FOR OTHER USES.

Peat is used to a small extent in the manufacture of refrigerating plants as an absorbent in small admixture with mineral wool, and also as an ingredient of certain kinds of stock foods, especially those containing beet-sugar molasses and other sugary wastes. In Europe its use in stock foods has become extensive, and has been approved, after careful tests, by the veterinarians of agricultural experiment stations and of some of the armies. Peat of the right sort makes an excellent absorbent for the molasses, rendering it easy to feed and also preventing fermentation.

No reports have been obtained of the quantity of peat used for these purposes.

IMPORTS.

In 1909 there were imported into the country from Europe 9,408 short tons of peat-moss litter, valued at $47,227.

For many years there has been an annual importation of peat litter into the United States for use in the large coastal cities, the largest importations being at New York, Philadelphia taking the second place. This material comes chiefly from Holland, and is brought into the country in burlap-covered bales. The peat from which it is made is evidently dug from the upper, poorly decomposed layers of beds of sphagnum and sedge peat, such as are of frequent occurrence in the northern part of the United States, especially in the New England States, but also in New York, Michigan, Indiana, Wisconsin, and Minnesota.

As bedding for horses and stock this peat litter is very serviceable and desirable, and it should be more widely produced and used than it is in this country.

SUMMARY.

The total production and consumption of peat for all purposes for 1909 is, so far as reported, shown in the following table:

Production and consumption of peat in United States in 1909, in short tons.

Use.	Production.		Imports.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Fuel	1,145	$4,145			1,145	$4,145
Fertilizer	26,768	118,891			26,768	118,891
Stable litter	1,254	4,006	9,408	$47,227	10,662	51,233
Total	29,167	127,042	9,408	47,227	38,575	174,269

CEMENT.

By Ernest F. Burchard.

INTRODUCTION.

The annual statistics of the mineral production of the United States are ordinarily collected by the United States Geological Survey alone, but those for 1909 were collected in cooperation with the Bureau of the Census in order to avoid annoyance to miners and manufacturers by duplicate requests from government bureaus. This cooperative arrangement necessarily resulted in considerable delay in the publication of the statistical reports for 1909, and the Survey was for that reason requested by many Portland cement manufacturers to collect the data on cement in the usual manner, and to issue a statement of production in advance of the census returns. This was accordingly done, with the approval of the Directors of the Census and the Geological Survey, and the advance statement of production, based on nearly complete returns, was finished on June 1, 1910. The acceptance of the figures obtained by the Bureau of the Census[a] has resulted in adding to the total production of Portland cement reported by the Survey in June, 1910, the quantity 2,482,970 barrels and the value $2,347,969; and to the production of natural cement the quantity 10,359 barrels and the value $29,615, making a total increase in quantity for all classes of cement of 2,493,329 barrels and in value of $2,377,584. This revision also resulted in increasing the average price for Portland cement in 1909 from 80.7 cents, as at first reported, to 81.3 cents per barrel in bulk at the mills.

PRODUCTION.

The total quantity of Portland, natural, and puzzolan cement produced in the United States during 1909 was 66,689,715 barrels, valued at $53,610,563. As compared with 1908, when the production was 52,910,925 barrels, valued at $44,477,653, the year 1909 showed an increase of 13,778,790 barrels, or 26.04 per cent, in quantity, and an increase of $9,132,910, or 20.53 per cent, in value. The increase in quantity is the largest ever recorded, but the failure of the increase in value to keep pace with the increase in production is significant of the trade conditions which the cement industry encountered during 1909.

The distribution of the total production among the three main classes of cement is shown in the following table. For comparison the figures for 1907 and 1908 are also presented.

[a] Additional figures for Portland cement were received after the Summary (Pt. 1, pp. 7-59) had gone to press.

Total production of cement in the United States in 1907, 1908, and 1909, by classes.

Class.	1907.		1908.		1909.	
	Quantity (barrels).	Value.	Quantity (barrels).	Value.	Quantity (barrels).	Value.
Portland	48,785,390	$53,992,551	51,072,612	$43,547,679	64,991,431	$52,858,354
Natural	2,887,700	1,467,302	1,686,682	834,509	1,537,638	652,756
Puzzolan	557,252	443,998	151,451	95,468	160,646	99,453
Total	52,230,342	55,903,851	52,910,925	44,477,653	66,689,715	53,610,563

PORTLAND CEMENT.

PRODUCTION.

The total production of Portland cement in the United States in 1909 as reported to the Geological Survey was 64,991,431 barrels, valued at $52,858,354. As compared with the production of 1908, which was 51,072,612 barrels, valued at $43,547,679, the output for 1909 represents an increase in quantity of 13,918,819 barrels, or 27.2 per cent, and an increase in value of $9,310,675, or 21.3 per cent.

The average price per barrel in 1909, according to the figures reported to the Survey, was therefore a trifle more than 81.3 cents. This represents the value of the cement in bulk at the mills, including the labor cost of packing, but not the value of the sacks or barrels. This average price is 11.8 cents higher than the average price received for cement in the Lehigh district, 10.3 cents higher than that for the Eastern States as a whole, about 2.3 cents higher than the average for the Central States, 1.3 cents higher than that for the Western States, 4.7 cents lower than the average price in the South, and 70.7 cents lower than the average price per barrel received at the Pacific coast plants. There are several reasons for this apparently high average for the whole country. Certain plants were able to command a price higher than the average, because practically their whole output was sold in near-by markets in which they had decidedly the advantage in freight rates. During the early part of the year prices were generally below the average, culminating in an extreme low level in the summer time. During this period many plants were shut down, or else operated under greatly reduced capacity. With revival of business in the fall, contracts were secured at prices which brought the average receipts for many such plants up to a point above the general average of those plants that did a large business on low margins throughout the year. Furthermore, the value of white Portland cement, which sells for a comparatively high price, is included in the general average, and also the values reported from the Pacific coast plants as well as the value of the cement manufactured by the plant of the United States Reclamation Service at Roosevelt, Ariz., all of which tends to increase the figure. As is shown in the table of geographic distribution, prices on the Pacific coast averaged considerably higher than in States east of the Rocky Mountains.

PRODUCTION BY STATES.

In the following table the Portland cement production is given by States or by groups of States where there are less than three producers in any single State. The grouping for 1908 and 1909 is made as nearly identical as was practicable. There was practically no change in the rank of producing States from 1908 to 1909:

Production of Portland cement in the United States in 1908 and 1909, by States.

1908.				1909.			
State.	Producing plants.	Quantity (barrels).	Value.	State.	Producing plants.	Quantity (barrels).	Value.
Pennsylvania	17	18,254,806	$13,899,807	Pennsylvania	24	22,869,614	$15,969,621
Indiana	7	6,478,165	5,386,563	Indiana	6	7,026,081	5,331,468
Kansas	7	3,854,603	2,874,457	Kansas	11	5,334,299	3,792,764
Illinois	5	3,211,168	2,707,044	Illinois	5	4,241,392	3,388,667
New Jersey	3	3,208,446	2,416,009	New Jersey	3	4,046,322	2,813,162
Missouri	4	2,929,504	2,571,236	Missouri	4	3,445,076	2,808,916
Michigan	15	2,892,576	2,556,215	Michigan	12	3,212,751	2,619,259
California	4	2,480,100	3,268,196	California	6	4,455,714	6,785,764
Washington	2			Washington	2		
New York	7	1,988,874	1,813,623	New York	7	2,139,884	1,859,169
Ohio	8	1,521,764	1,305,210	Ohio	8	1,813,521	1,359,245
Iowa	1	1,205,251	1,176,499	Iowa	1	1,265,944	1,117,338
Kentucky	1			Kentucky	1		
Tennessee	1			West Virginia	1		
Texas	2	917,977	924,039	Texas	3	1,438,021	1,519,267
Oklahoma	2			Oklahoma	2		
South Dakota	1	809,306	1,057,433	South Dakota	1	1,019,328	1,024,317
Colorado	2			Colorado	2		
Arizona	1	507,603	805,235	Arizona	1	663,679	923,847
Utah	2			Utah	2		
Maryland	1	502,225	511,118	Maryland	1	949,331	667,163
Virginia	1			Virginia	1		
Massachusetts	1			Massachusetts	1		
Alabama	2	310,244	274,995	Alabama	1	1,070,474	878,387
Georgia	1			Georgia	1		
				Tennessee	1		
Total	98	51,072,612	43,547,679	Total	108	64,991,431	52,858,354

PRODUCTION BY DISTRICTS.

The present geographic distribution of the Portland-cement industry is indicated in the following tables, where the total production of the years 1906, 1907, 1908, and 1909 is grouped according to locality. The term "East," as used in these tables, includes plants in Pennsylvania, New Jersey, New York, and Massachusetts. The "Central" plants are those in Ohio, Indiana, Michigan, Illinois, Iowa, and Missouri. Under "West" are included plants in Kansas, Colorado, South Dakota, Utah, and Arizona. On the Pacific coast plants are operating in California and Washington. In the South plants are located in Maryland, Virginia, West Virginia, Kentucky, Tennessee, Georgia, Alabama, Oklahoma, and Texas.

Geographic distribution of the Portland-cement industry, 1906–1909.

District.	Output, in barrels.				Average price per barrel.	
	1906.	1907.	1908.	1909.	1908.	1909.
East	25,483,025	27,134,816	23,472,126	29,062,798	$0.78	$0.71
Central	14,030,665	13,479,703	17,744,034	20,669,596	.86	.79
West	3,834,656	4,463,397	5,171,512	7,017,306	.91	.80
Pacific coast	1,310,435	1,893,004	2,480,100	4,455,714	1.32	1.52
South	1,804,643	1,814,470	2,204,840	3,786,017	.92	.86
Total	46,463,424	48,785,390	51,072,612	64,991,431	....	....

District.	Plants in operation.				Percentage of total output.			
	1906.	1907.	1908.	1909.	1906.	1907.	1908.	1909.
East	31	34	28	35	54.9	55.6	46.0	44.7
Central	34	37	40	36	30.2	27.6	34.7	31.8
West	8	10	13	17	8.2	9.2	10.1	10.8
Pacific coast	4	5	6	8	2.8	3.9	4.9	6.9
South	7	8	11	12	3.9	3.7	4.3	5.8
Total	84	94	98	108	100.0	100.0	100.0	100.0

PRODUCTION OF THE LEHIGH DISTRICT, 1890–1909.

The Lehigh district of Pennsylvania-New Jersey for the first time showed a decrease in production of Portland cement in 1908. In 1909 there was a substantial increase of 4,046,319 barrels, but the annual output did not quite reach that of 1906, and fell considerably short of the high level of 1907. The increase in production for 1909 over that of 1908 amounted to 20.03 per cent as compared with an increase of 27.2 per cent for the whole country. This relative decrease in output is also shown in the steadily decreasing percentage of the total production which is supplied by the Lehigh district. In 1899 this district produced nearly 73 per cent of the Portland cement manufactured in the United States; ten years later the proportion was only 37.3 per cent. In 1908, 17 firms reported production of Portland cement in the Lehigh district, and the average price per barrel as reported to the survey was 75 cents. In 1909, 22 plants reported production, with an average price of a trifle less than 69.5 cents per barrel.

The following table shows, by three-year periods since 1890, the production of the Lehigh district, the total production, and the percentage of the Lehigh district output to the total production:

Portland-cement production in the Lehigh district and in the United States, 1890–1909, in barrels.

Year.	Lehigh district output.	Total output.	Percentage of total manufactured in Lehigh district.	Year.	Lehigh district output.	Total output.	Percentage of total manufactured in Lehigh district.
1890	201,000	335,500	60.0	1900	6,153,629	8,482,020	72.6
1891	248,500	454,813	54.7	1901	8,595,340	12,711,225	67.7
1892	280,840	547,440	51.3	1902	10,829,922	17,230,644	62.8
1893	265,317	590,652	44.9	1903	12,324,922	22,342,973	55.2
1894	485,329	798,757	60.8	1904	14,211,039	26,505,881	53.7
1895	634,276	990,324	64.0	1905	17,368,687	35,246,812	49.3
1896	1,048,154	1,543,023	68.1	1906	22,784,613	46,463,424	49.0
1897	2,002,059	2,677,775	74.8	1907	24,417,686	48,785,390	50.0
1898	2,674,304	3,692,284	72.4	1908	20,200,387	51,072,612	39.6
1899	4,110,132	5,652,266	72.7	1909	24,246,706	64,991,431	37.3

GROWTH OF THE PORTLAND CEMENT INDUSTRY, 1890-1909.

The growth of the industry for the years 1890 to 1909, inclusive, illustrated graphically in figure 1. For comparison, the decline in ne natural cement industry is plotted on the same diagram.

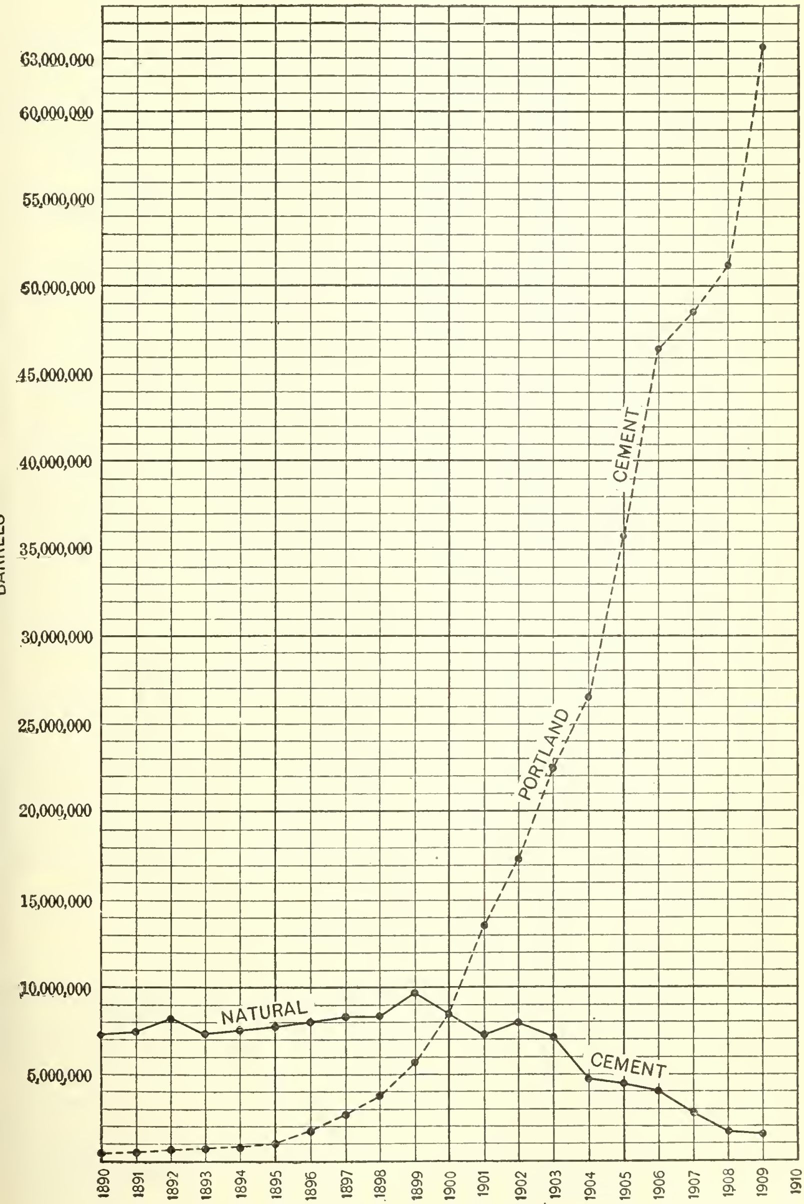

FIGURE 1.—Comparison of production of Portland and natural cement.

NOTE.—Since this cut was made additional figures have been received which will carry the curve up arly to the 65,000,000 mark.

In the following table statistics are given covering the annual production of Portland cement in the United States from the inception of the industry in the early seventies to the present day.

Production of Portland cement in the United States, 1870–1909, in barrels.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
1870–1879	82,000	$246,000	1894	798,757	$1,383,473
1880	42,000	126,000	1895	990,324	1,586,830
1881	60,000	150,000	1896	1,543,023	2,424,011
1882	85,000	191,250	1897	2,677,775	4,315,891
1883	90,000	193,500	1898	3,692,284	5,970,773
1884	100,000	210,000	1899	5,652,266	8,074,371
1885	150,000	292,500	1900	8,482,020	9,280,525
1886	150,000	292,500	1901	12,711,225	12,532,360
1887	250,000	487,500	1902	17,230,644	20,864,078
1888	250,000	487,500	1903	22,342,973	27,713,319
1889	300,000	500,000	1904	26,505,881	23,355,119
1890 [a]	335,500	704,050	1905	35,246,812	33,245,867
1891	454,813	967,429	1906	46,463,424	52,466,186
1892	547,440	1,153,600	1907	48,785,390	53,992,551
1893	590,652	1,158,138	1908	51,072,612	43,547,679
			1909	64,991,431	52,858,354
			Total	352,674,246	360,771,354

[a] The figures for 1890 and prior years were estimates made at the close of each year, but are believed to be substantially correct. Since 1890 the official figures are based on complete returns from all producers.

On examination of this table it will be seen that the industry showed a fair but not in any way remarkable rate of growth from its commencement in the seventies until 1895. At the latter date, however, a very striking development commenced, coincident, it may be noted, with the development of coal burning in the rotary kiln. This rapid rate of growth continued until 1907, when it was checked temporarily by the financial crisis of that year.

On examining the cement statistics for the series of years, it will be seen that the output of Portland cement has so far shown an increase each year, rising from 42,000 barrels in 1880 to 335,500 barrels in 1890, to 8,482,020 barrels in 1900, and to 64,991,431 barrels in 1909. The natural cement production, on the other hand, reached its maximum in 1899, with an output of 9,868,179 barrels. Since that year it has shown an almost continuous and rapid decrease annually, until now it has become a relatively unimportant factor in the cement situation.

CEMENT PRICES, 1880–1909.

One of the most striking features connected with the Portland cement industry in this country has been the decline in cement prices during the last thirty years. This decline has, as a matter of fact, been as steady and as marked as the growth in annual output.

The decreases in the price of cement have been due to two factors. In the earlier years of the industry there were periodical decreases in cost of production, and in recent years the intense competition between manufacturers has been the main reducing influence. Eckel [a] has pointed out that the great decreases in costs came in

[a] Eckel, E. C., The Portland cement industry from a financial standpoint: Moody's Magazine, New York, 1908, pp. 31–32, and 43–44.

three abrupt steps coincident with radical changes in the methods of manufacture. First, the general adoption of the rotary kiln was the cause of sharp reductions in manufacturing costs; a second fall in costs occurred when powdered coal became the standard fuel in the rotary kiln; and third, the adoption of long rotary kilns has shown a gain in output. Eckel also states that so long as there are no very radical changes in present methods of cement manufacture, no further marked decreases in operating costs can be expected; and since the manufacturing costs at well-conducted plants have in the last two years reached levels which can not be greatly lowered in the near future, cement prices can not be expected to decrease at a rate comparable to that which has already been experienced.

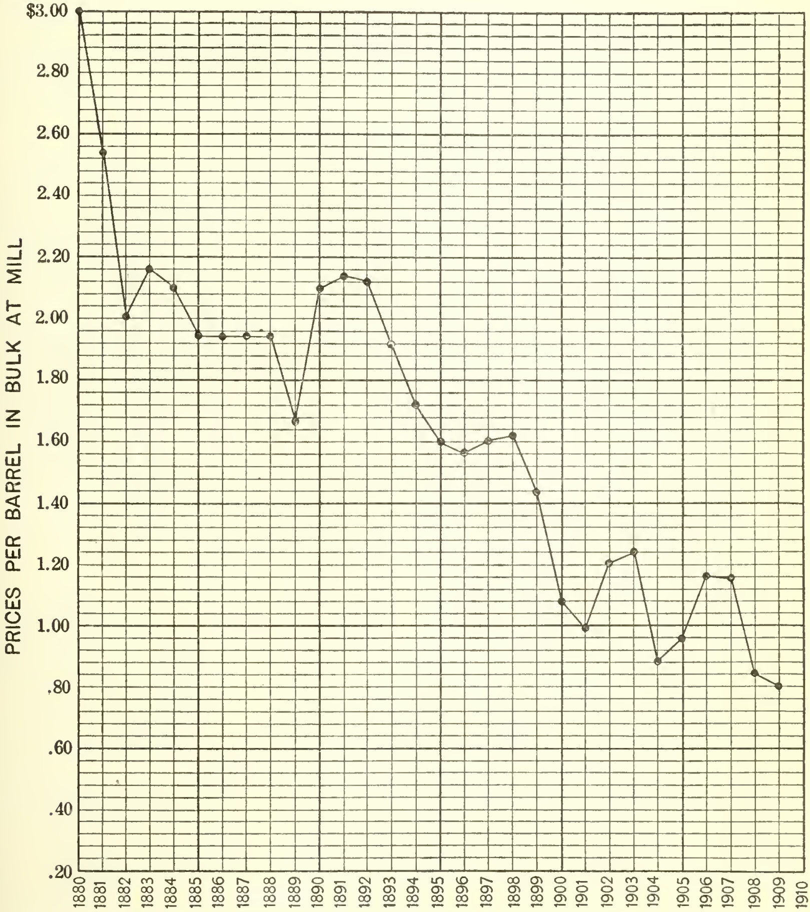

FIGURE 2.—Range in cement prices, 1880–1909.

As regards annual output, this may be expected to increase as population increases and new uses are found for cement. It can hardly be expected that the increase will in the future be as steady as in the past. It is rather more probable that the cement trade will in future years more nearly correspond to the condition of general business.

The following table gives the average price per barrel of Portland cement in bulk at the point of manufacture, derived from the official figures published annually by the Geological Survey. The price excludes the cost of the package, but includes the labor cost of packing.

Average prices per barrel of Portland cement, 1870–1909.

1870–1880	$3.00	1892	$2.11	1901	$0.99
1881	2.50	1893	1.91	1902	1.21
1882	2.01	1894	1.73	1903	1.24
1883	2.15	1895	1.60	1904	.88
1884	2.10	1896	1.57	1905	.94
1885–1888	1.95	1897	1.61	1906	1.13
1889	1.67	1898	1.62	1907	1.11
1890	2.09	1899	1.43	1908	.85
1891	2.13	1900	1.09	1909	.813

MANUFACTURING CONDITIONS.

In 1909, 108 plants reported production of Portland cement. The total number of rotary kilns reported as in operation during the year was 930. These kilns ranged in length from 40 to 160 feet. Very few kilns were reported as being less than 60 feet long, and of the 930 kilns 431 were reported as 100 feet or more in length. From the reports received it is evident that the average of the operating time for all the kilns in the United States was about 70 per cent. The total annual kiln capacity of the country in 1909, deducting for a reasonable loss of time for repairs, is estimated at about 86,200,000 barrels of Portland cement. According to these figures the total production of 64,991,431 barrels was about 75 per cent of the total capacity. The average output per kiln for 1909 was about 69,388 barrels.

DEMAND AND SUPPLY.

Comments on the condition of the trade beyond those given in the analyses of production and prices in preceding pages would be superfluous here. The laconic comment of most of the cement producers at the close of 1909 was "demand more active in 1909, but prices lower." A very few manufacturers reported better conditions in every respect; others reported that conditions were about the same, and some few that conditions were unsatisfactory.

According to the foregoing figures regarding kiln capacity, which represent the situation exactly as reported to the Survey by the producers, it is evident that if all of the Portland cement mills at present operating were to be run full time and full capacity, it should be possible to supply the demand for cement in the United States for some years to come, without any great additions to the kiln capacity. At present there are many localities so remote from a cement plant that high freight charges render the use of cement almost prohibitive, but on the other hand if the region is sparsely settled the market is likely to be too limited to warrant the establishment of a new plant in any such locality. A large number of new plants have been projected within the last three or four years. The financial stringency of 1907 caused many of these projects to be abandoned, and more recently the keen competition which has resulted in the lowering of prices has discouraged the promotion of several other projected plants. Some of the new projects have, however, been carried through to completion, and the year 1909 saw seven plants added to the list of Portland cement producers, besides witnessing the partial construction of several others. One new producing plant is in California; three are in Kansas, one in Missouri, one in Pennsylvania, and one in Texas. Besides these, one plant in West Virginia which was idle in 1908 resumed operations in 1909. On the other hand, there were three or four plants in the United States that were idle in 1909, although operating to a certain extent in 1908. In the totals for 1908, all mills operated by a single firm were counted as one plant. For 1909 the term "producing plant" is applied to each mill or group of mills located at one place and operated by one firm, so that each plant of that company located in a separate place is counted as a plant. This, together with two new producers in Pennsylvania, accounts for the gain of seven plants in that State. In Michigan two plants which operated in 1908 were idle in 1909, and in 1909 one plant, consisting of two mills, was counted as one plant, whereas in 1908 it was counted as two plants. This accounts for the apparent loss of three producing plants in Michigan. In Alabama one plant which was operated in 1908 reported no production in 1909.

It is only a few years since the demand for Portland cement at most seasons exceeded the supply. With the increase in the number of producing plants and the increase in capacity of the older plants, stocks of cement soon became sufficient to supply the market at most seasons of the year, and recently considerable surplus stocks have at times accumulated. This condition has stimulated the marketing of cement, and at present not only the ingenuity of the user of cement is actively at work but also that of the manufacturer, in order to provide new uses and enlarging markets for the material. Although competition is now very keen between rival cement manufacturing interests, a broad cooperative policy has been adopted by the officials of some twenty-two large Portland cement companies and other interested parties, all of whom realize that whatever benefits the industry at large will ultimately benefit the individual producers. The Cement Products Exhibition that has been held at Chicago in February of recent years is the result of this broad policy of cooperative advertisement and instruction. This exhibition has become an annual affair in Chicago, and it has been announced that a similar exhibition is to be held by the same association in New York City in December, 1910.

NATURAL CEMENT.

PRODUCTION.

The natural cement produced in the United States during 1909 amounted to 1,537,638 barrels, valued at $652,756, as compared with an output of 1,686,862 barrels, valued at $834,509, in 1908, a decrease in 1909 of 149,224 barrels, or over 8 per cent, in quantity, and of $181,753, or over 21 per cent, in value.

The average price of natural cement per barrel at the mills was 49 cents in 1908 and 42 cents in 1909.

PRODUCTION BY STATES.

In the following table the natural cement production of 1909 is classified by States, the figures for 1908 being given for comparison:

Production of natural cement in 1908 and 1909, by States.

1908.

State.	Producing plants.	Quantity (barrels).	Value.
New York	6	623,618	$441,136
Pennsylvania	3	252,479	87,192
Indiana	3	212,901	42,580
Illinois	2	188,859	68,772
Kansas	2		
Texas	1	87,159	47,725
Colorado	1		
Kentucky	2		
Georgia	1	119,656	53,904
Ohio	1		
Minnesota	2	202,190	93,200
Wisconsin	1		
Total	25	1,686,862	834,509

1909.

State.	Producing plants.	Quantity (barrels).	Value.
New York	7	545,500	$267,188
Pennsylvania	3	295,085	98,673
Indiana	3		
Illinois	1	368,299	137,078
Ohio	1		
Kansas	1		
Kentucky	1	117,185	52,689
Georgia	1		
Texas	1		
Minesota	2	211,569	97,128
Wisconsin	1		
Total	22	1,537,638	652,756

THE NATURAL-CEMENT INDUSTRY, 1818-1909.

The following table contains statistics relative to the natural cement industry since its commencement in this country in 1818. It will be seen that the natural-cement trade reached its greatest prosperity in the period 1887-1903, inclusive, its year of maximum output being 1899, when 9,868,179 barrels of natural cement were manufactured in the United States. Beginning with 1904, the industry has shown marked and continuous decline in production each year, and its production for 1909 is the lowest on record since 1870.

Production of natural cement in the United States, 1818-1909, in barrels.

1818-1829	300,000
1830-1839	1,000,000
1840-1849	4,250,000
1850-1859	11,000,000
1860-1869	16,420,000
1870-1879	22,000,000
1880	2,030,000
1881	2,440,000
1882	3,165,000
1883	4,190,000
1884	4,000,000
1885	4,100,000
1886	4,186,152
1887	6,692,744
1888	6,253,295
1889	6,531,876
1890	7,082,204
1891	7,451,535
1892	8,211,181
1893	7,411,815
1894	7,563,488
1895	7,741,077
1896	7,970,450
1897	8,311,688
1898	8,418,924
1899	9,868,179
1900	8,383,519
1901	7,084,823
1902	8,044,305
1903	7,030,271
1904	4,866,331
1905	4,473,049
1906	4,055,797
1907	2,887,700
1908	1,686,862
1909	1,537,638
Total	228,639,90[illegible]

PUZZOLAN CEMENT.

PRODUCTION.

Puzzolan cement, made by mixing blast-furnace slag with slaked lime, was manufactured during 1909 at four plants in the United States. The output reported for 1909 was 160,046 barrels, valued at $99,453. This shows an increase when compared with the production reported for 1908, which was 151,451 barrels, valued at $95,468.

The average price per barrel of puzzolan cement in 1908 was 63 cents; in 1909 it was a trifle less than 62 cents.

The following table contains the leading facts relative to this industry for the five years from 1905 to 1909, inclusive.

Statistics of the puzzolan cement industry, 1905–1909, by States.

	1905.	1906.	1907.	1908.	1909.
Number of plants reporting production:					
Alabama	2	2	1	1	1
Illinois	1	1	1		
Kentucky	1	1	1		
Maryland	1	1			
New Jersey	1	1			
New York		1	1		
Ohio	2	2	2	2	2
Pennsylvania	1	1	1	1	1
Total	9	10	7	4	4
Production in barrels	382,447	481,224	557,252	151,451	160,646
Value of production	$272,614	$412,921	$443,998	$95,468	$99,453

The following table includes statistics relative to the production of puzzolan cement in the United States since 1896, when the first output of this product was reported:

Production of puzzolan cement in the United States, 1896–1909, in barrels.

1896	12,265	1904	303,045
1897	48,329	1905	382,447
1898	150,895	1906	481,224
1899	335,000	1907	557,252
1900	446,609	1908	151,451
1901	272,689	1909	160,646
1902	478,555		
1903	525,896	Total	4,306,303

IMPORTS OF FOREIGN CEMENT.

The following table shows the foreign cement imported into the United States during the years 1878 to 1909, inclusive. It is to be noted that, owing to the manner in which import statistics are grouped under existing tariff schedules, the quantities given include not only Portland cement, but all other hydraulic cements. The Portland cement, however, probably makes up at least 95 per cent of the total in each year.

Imports of foreign cement, 1878–1909, in barrels.

1878	92,000	1889	1,740,356	1900	[a]2,386,683
1879	106,000	1890	1,940,186	1901	[a]939,330
1880	187,000	1891	2,988,313	1902	[a]1,963,023
1881	221,000	1892	2,440,654	1903	[a]2,251,969
1882	370,406	1893	2,674,149	1904	[a]968,409
1883	456,418	1894	2,638,107	1905	[a]896,845
1884	585,768	1895	2,997,395	1906	[a]2,273,493
1885	554,396	1896	2,989,597	1907	[a]2,033,438
1886	915,255	1897	2,090,924	1908	[a]842,121
1887	1,514,095	1898	1,152,861	1909	[a]443,888
1888	1,835,504	1899	[a]2,108,388		

EXPORTS.

The United States now possesses only a small export trade in cement, the quantity annually exported ranging usually between 1 per cent and 3 per cent of the domestic production. There seem to be excellent reasons for increasing this export trade as rapidly as possible, and it may soon become a more important feature of the industry.

The following table gives the quantity and value of all classes of hydraulic cement exported during the years 1900–1909, inclusive. These totals represent almost entirely exports of Portland cement.

Exports of hydraulic cement, 1900–1909, in barrels.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
1900	100,400	$225,306	1905	897,686	$1,387,906
1901	373,934	679,296	1906	583,299	944,886
1902	340,821	526,471	1907	900,550	1,450,841
1903	285,463	433,984	1908	846,528	1,249,229
1904	774,940	1,104,086	1909	1,056,922	1,417,534

APPARENT ANNUAL CONSUMPTION OF PORTLAND CEMENT.

The following table contains data on the apparent annual consumption of Portland cement in the United States for recent years. The computed results are of course merely approximations to the truth, for unavoidable errors arise from the facts that (*a*) both imports and exports, as reported officially, include not only Portland but small quantities of other classes of cement; and (*b*) no data are available as to stocks on hand at mills or at distributing points at the close of each year.

Apparent annual consumption of Portland cement, 1902–1909, in barrels.

Year.	Domestic production.	Imports.	Total available supply.	Exports.	Apparent consumption.
1902	17,230,644	1,963,023	19,193,667	340,821	18,852,846
1903	22,342,973	2,251,969	24,594,942	285,463	24,309,479
1904	26,505,881	968,410	27,474,291	774,940	26,699,351
1905	35,246,812	896,845	36,143,657	897,686	35,245,971
1906	46,463,424	2,273,493	48,736,917	583,299	48,153,618
1907	48,785,390	2,033,438	50,818,828	900,550	49,918,278
1908	51,072,912	842,121	51,915,033	846,528	51,068,505
1909	64,991,431	443,888	65,435,319	1,056,922	64,378,397

[a] "Imports for consumption." The figures given for all other years are for "total imports."

RECENT DEVELOPMENTS AND NEW USES OF CEMENTS.

WHITE PORTLAND CEMENT.

One of the newer developments in cement manufacture is the production of white nonstaining Portland cement. Three or more brands are being made in the United States, principally to supply a growing demand for ornamental work and surface finish, both interior and exterior. The white cement is finding successful application and can be made to pass specifications for ordinary gray Portland cement. It is not, however, used as a structural cement, but rather for ornamental purposes, so that the tendency to lower strength, due to high alumina, is not a detriment. The conditions under which white Portland cement can be manufactured are rather restricted as compared with those necessary for gray Portland cement. Raw materials suitable for the white cement are not widely distributed and must be selected with great care; silica and alumina must be properly proportioned, and iron oxide must not be present in excess of 0.2 per cent in the finished cement. Therefore limestone and clay that are low in iron oxide, or preferably, practically free from this material, are necessary in the manufacture of a colorless cement. With the use of materials low in iron it has been found essential to add an iron-free fluxing material which shall perform the functions of the iron in effecting combination between the silica and the alumina. In one of the white nonstaining cements manufactured in the United States under patent rights, 2 to 5 per cent of cryolite, calcium-aluminum fluoride, is the material employed as a flux. In view of these restricted conditions the cost of manufacturing white Portland cement is considerably greater than that of gray Portland cement, and as yet the demand has been more limited; hence the manufacture is conducted on a smaller and consequently on a more expensive scale than in the case of the gray cement.

CEMENT IN ART AND ARCHITECTURE.

A most promising but little developed field for the use of cement in the United States to-day is that of architectural and art work. In Europe, especially in Germany, cement has long been used to an important extent in ornamental and figure work. There are large opportunities for the application of cement in cornices to replace wood and metal, not only on concrete houses, but also on brick and stone structures. Besides the possibilities for the use of cement in the construction of fronts, there is a wide range of possibility in the artistic use of cement in interior decoration. Handsome mantels, friezes, and cornices, are being successfully made of it, and separate pieces, such as statuary, urns, lamp bases, pedestals, tables, seats, and many other classes of sculptural and ornamental work, can be produced. The recent Cement Products Exhibition at Chicago, February, 1910, gave ample illustrations of the interesting possibilities in this direction, and many illustrated suggestions are offered in one of the recent technical journals devoted to the uses of cement.[a]

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[a] Cement Age. New York, November, 1909, and January, 1910.

CEMENT AS A ROAD MATERIAL.

A great deal of cement is at present used in paving, principally in concrete bases or foundations for granite block, brick, creosoted block, and asphalt pavements. Pavements entirely of concrete, the top being finished with cement, have recently been laid in some small cities of the Middle West. When protected from direct exposure, as in the case of pavements surfaced with another material, the concrete foundations give good satisfaction. Contraction cracks in pavements laid wholly of concrete are, however, very difficult to avoid even when the pavement is divided into large blocks by means of joints which are designed to permit of contraction and expansion of the mass, and it is therefore a question whether or not more satisfactory methods of construction or treatment can be devised by which concrete can be used as a wearing surface for roads. This problem is being investigated by the Bureau of Public Roads, and the chief of this bureau, Dr. L. W. Page,[a] has offered some new suggestions. According to Doctor Page, in most concrete roads the concrete is too uniformly mixed and too homogeneous in composition, and this condition may account in part for the development of shrinkage cracks where the surface is exposed to a great range of temperature. Concrete is considered too unyielding to the blows of traffic and too brittle, and therefore tends to spall.

Two general methods of preparing a concrete pavement which will obviate these undesirable characteristics are suggested by Doctor Page. In one case the use of cement mortar as a binding matrix for crushed stone is suggested, and in the other the use of a mixture of semiasphaltic base oils with Portland cement concrete is outlined. Some tests have been made by the Office of Public Roads to ascertain the practicability of such a mixture, and the results are reported as encouraging. If a practicable mixture is obtained with reduced brittleness and increased resilience and toughness, the value of cement as a road-building material will be very much increased, and the demand for it should be correspondingly enlarged.

PAINTS FOR CONCRETE.

The use of cement concrete for structural purposes has already become world-wide, and it is increasing at a rapid rate. Heretofore little attention has been paid to coatings for concrete. Enough time has now elapsed to show that cement concrete alone is not as durable as might be wished, partly because it is not wholly waterproof and partly because the cement either contains free lime or develops free lime within itself after setting. Furthermore, concrete in order to compete with other structural materials has had to be economically handled and roughly finished, and its resulting unsightly appearance has detracted from its desirability. It is therefore clear that there is great necessity for both protective and decorative coatings for concrete. The problem of waterproofing concrete is being studied from several standpoints besides that of applying protective coatings. For instance, the endeavor to reduce the voids in concrete to a minimum, as well as to obtain uniformly finely ground cement and to eliminate

[a] Page, L. W., The possibilities of Portland cement as a road material: Cement Age, January, 1910, pp. 37–40; also Engineering Record, December 25, 1909, pp. 724–725.

the tendency of the cement to form free lime in setting, are all absolutely necessary steps in the production of a waterproof concrete and are the special business of the cement manufacturer and engineer of construction to work out. Much experimental work is under way with regard to waterproofing concrete by means of the addition of various foreign substances in small quantities to the aggregate. Some of these materials are of mineral composition and others are organic. Many compounds are now on the market, but the composition of most of them is not published. Some analyses have been made recently [a] on a series of compounds widely advertised for use in waterproofing, strengthening, or decorating concrete. Among the materials contained were stearic acid compounds, gums, waxes, soaps, mineral chlorides, inert pigments, and asphalt derivatives. Much interesting information is given regarding the composition of such compounds, although the names of the particular compounds are not given. The possibility of ultimate deleterious effects on concrete from the use of these internal waterproofing materials is a subject for joint study by engineers and paint chemists. In addition to proving the advantages of such materials as water excluders, it should be determined whether they may corrode the steel used in reinforcing concrete or whether they may affect the set and tensile strength of the cement itself.

It is particularly the province of the paint chemists to study the subject of paint coatings for concrete. Oil coatings have been found to be badly affected by the free lime present, which causes saponification and subsequent solution of the saponified coating. The porosity of cement or concrete surfaces causes an absorption or suction effect that renders it necessary to apply to a given area three or four times as much paint as would cover an equivalent area of wood. Two very important lines of investigation are therefore suggested—the neutralization of the free lime in the cement and concrete and the proper filling and treatment of the pores of the concrete—in order to prevent the suction of any paint that may be applied later. One suggestion that promises to be of great importance in both of these lines has been made by Mr. Charles Macnichol, a master painter, of Washington, D. C.[b] Macnichol suggests that a solution of zinc sulphate and water mixed in equal parts by weight (8 pounds zinc sulphate to 1 gallon water) be used as a priming coat, which when applied to concrete surfaces results in a reaction between the zinc sulphate and the free lime, in so far as the material penetrates the concrete. The products of this reaction are calcium sulphate and zinc hydroxide. There is thus precipitated between the pores of the concrete two practically insoluble pigments, both neutral, and these tend to fill the voids and pores and thus to lessen the suction properties of the concrete, besides having neutralized the free lime in the cement. After the application of this priming coat, oil coatings may probably be applied with good results, although whether an excess of zinc sulphate in this treatment may do harm has not yet been determined. Other treatments have been suggested, but most of them have been found defective or else too expensive.[c]

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[a] Bull. Sci. Sec. Paint Mfrs. Assoc. No. 20, 1909, pp. 14–19.
[b] Painters Magazine, New York, March, 1908, pp. 223–224.
[c] Bull. Sci. Sec. Paint Mfrs. Assoc. No. 20, 1909, pp. 13–14.

NOTES ON UNDEVELOPED CEMENT MATERIALS.

UNITED STATES.

Although public interest in the raw materials for the manufacture of Portland cement is not at present so great as it was a few years ago, owing to the rapid extension of the industry throughout the country, inquiries are continually being received by the United States Geological Survey regarding the situation of suitable available deposits, as well as regarding the methods of investigating them, of testing the materials, and of manufacturing cement.

Survey publications on this subject are mostly out of stock, but a list is given at the end of this chapter showing those that are available for free distribution by the Survey and those that may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., with the prices charged for them. The technical press is at present well supplied with articles dealing with the manufacture, properties, and uses of cement, but only at rare intervals do papers appear in it treating of deposits of raw materials. Some notice has, however, been given in this way to cement materials in Alabama, Colorado, and Oklahoma.[a]

From time to time investigative work is done by certain of the state geological surveys and many fairly detailed reports have been published on important local deposits. The surveys of the following States have made special studies of local cement resources: Alabama, California, Illinois, Indiana, Iowa, Maryland, Michigan, Mississippi, Missouri, New Jersey, New York, North Dakota, Ohio, South Dakota, Virginia, West Virginia.

The respective reports are listed below:

ALABAMA: SMITH, E. A., and ECKEL, E. C. The cement resources of Alabama, and the materials and manufacture of Portland cement: Bull. Alabama Geol. Survey No. 8, 1904, 93 pp.

CALIFORNIA: AUBURY, LEWIS E. The structural and industrial materials of California, pp. 171–189: California State Min. Bureau, San Francisco, Cal., 1906.

ILLINOIS: BLEININGER, A. V., and LINES, E. F. Cement materials and manufacture in Illinois: Bull. Illinois Geol. Survey (in preparation).

INDIANA: BLATCHLEY, W. S., and ASHLEY, G. H. Portland cement; The lakes of northern Indiana and their associated marl deposits; Oolite and oolitic stone for Portland cement manufacture: Twenty-fifth Ann. Rept. Indiana Dept. Geol. and Nat. Res., 1901, pp. 1–330.

IOWA: ECKEL, E. C., and BAIN, H. F. Cement and cement materials of Iowa: Iowa Geol. Survey, vol. 15, 1904, pp. 33–124.

BEYER, S. W. Supplementary report on Portland cement materials in Iowa: Bull. Iowa Geol. Survey No. 3, 1906, 36 pp.

BEYER, S. W., and WILLIAMS, I. A. The materials and manufacture of Portland cement: Iowa Geol. Survey, vol. 17, 1906, pp. 29–89.

MARYLAND: MATHEWS, E. B., and GRASTY, J. S. The limestones of Maryland with special reference to their use in the manufacture of lime and cement: Maryland Geol. Survey, vol. 8, pt. 3, pp. 225–484, 14 pl., map. Baltimore, 1910.

MICHIGAN: HALE, D. J., and others. Marl (bog lime) and its application to the manufacture of Portland cement: Michigan Geol. Survey, vol. 8, pt. 3, 1903, 386 pp.

MISSISSIPPI: CRIDER, A. F. Cement and Portland cement materials of Mississippi: Bull. Mississippi State Geol. Survey No. 1, 1907.

MISSOURI: BUEHLER, A. H. Lime and cement resources of Missouri: Missouri Geol. Survey, vol. 6, 2d ser., 1907, 255 pp.

NEW JERSEY: KUMMEL, H. B. Report on Portland cement industry: New Jersey Geol. Survey, Ann. Rept. for year 1900, pp. 9–101.

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[a] Fall, Dr. Delos, and Cooper, W. F., The raw materials for Portland cement of Alabama, with analyses: Mich. Min., June and July, 1909.

Bancroft, Geo. J., Portland cement in Rocky Mountain region: Min. Sci., January 2, 1908.

Lakes, A., Portland cement material in Colorado; Min. Sci., vol. 59, No. 1531, June 3, 1909, p. 427.

Hutchison, L. L., Oklahoma Portland cement possibilities: Mfrs. Record, May 20, 1909, p. 45.

Posegate, F. M., Cement and concrete in Oklahoma: Mfrs. Record, February 24, 1910, pp. 55–57.

NEW YORK: RIES, H. Lime and cement industries of New York: Bull. New York State Museum No. 44, 1903, pp. 640–848.

NORTH DAKOTA: BARRY, J. G., and MELSTED, V. J. Geology of northeastern North Dakota, with special reference to cement materials: North Dakota Geol. Survey, 5th biennial report, 1908, pp. 115–225.

OHIO: BLEININGER, A. V. Manufacture of hydraulic cements: Bull. Ohio Geol. Survey No. 3, 4th ser., 1904.

ORTON, E., Jr., and PEPPEL, S. V. The limestone resources and the lime industry in Ohio: Bull. Ohio Geol. Survey No. 4, 4th ser., 1906.

SOUTH DAKOTA: TODD, J. E. Cements and clays; Mineral resources of South Dakota: Bull. South Dakota Geol. Survey No. 3, 1902, pp. 98–109.

VIRGINIA: BASSLER, R. S., and ECKEL, E. C. Cement resources of Virginia west of the Blue Ridge: Bull. Virginia Geol. Survey No. II–A, 1909, 309 pp.

WEST VIRGINIA: GRIMSLEY, G. P. Cement industry and cement resources in West Virginia: West Virginia Geol. Survey, vol. 3, 1905, pp. 423–555.

PHILIPPINE ISLANDS.

Mr. Alvin J. Cox has called attention to the raw materials for Portland cement available in the Philippine Islands.[a] According to Cox, limestone occurs abundantly on nearly every island of the Philippine Archipelago, and on the island of Batan it is uniformly remarkably pure. Clay or shale suitable for the manufacture of high-grade Portland cement is, however, more difficult to obtain on the island of Batan. These facts are borne out in a series of analyses of samples of shale and limestone from drill holes, and the data are discussed in relation to the requirements of the best manufacturing practice. The calculations show that cements might be made from materials such as those taken from the drill holes on Batan Island that would agree fairly well with the theoretical analysis for Lehigh district cement, although the silica-alumina ratio is low and the composition of the product would barely come within the desirable limits proposed by Meade and Le Chatelier. Cox regards it as probable that the addition of silica in some form to the materials would be necessary in order to produce a wholly satisfactory cement. A less quantity of limestone would be needed as a consequence, and a larger deposit of shale would have to be available in order to produce a given quantity of cement than would be the case under normal conditions.

In the Mount Licos region, near Danao, Cebu, some surveys and a few borings have been made. Limestone occurs abundantly in more or less detached areas over the region, ranging in thickness from 100 to 500 feet, and shales, including five coal seams, are of wide distribution and range from 300 to 500 feet thick. Analyses of the materials are given, and combinations based on theoretical calculations are made. Here, also, some of the shale samples do not run as high in silica as might be desired, although a mixture which nearly corresponds to the theoretical analysis of good Portland cement can be easily made by using a higher proportion of clay and less limestone than is the practice in the United States. The addition of silica also is recommended if these materials be used. It is suggested in this connection that siliceous materials might be derived from the schists that occur on the island of Romblon and in Cebu.

A study of the coals in the Philippine Islands has also been made, and their values as fuels in burning cement are considered. Experi-

[a] Cox, Alvin J., Philippine raw cement materials: Philippine Jour. Sci., May, 1909, pp. 211-229; Volcanic tuff as a construction and a cement material: Philippine Jour. Sci., November, 1908, pp. 391-406.

mental work has shown that although Philippine coals do not possess quite as great fuel value as that of the gas coal of Fairmont, W. Va., they do give promise of being suitable for kiln fuel in burning Portland cement and that they are as good as any coals available in the markets of the Philippine and neighboring countries.

The vicinity of the city of Cebu has attracted the most attention as a possible cement-making locality on account of its proximity to limestone, shale, and coal supplies, and because of the fact that Cebu is an open port, which makes transportation favorable and simplifies labor conditions.

Another raw material that has been suggested as possibly available for making Portland cement in connection with pure limestone is the volcanic tuff that is widely distributed in the Philippine Islands. Tuffs are reported to be especially abundant in west-central Luzon, extending almost unbrokenly from near Lingayen Gulf to the seacoast of Batangas, practically blanketing nearly all of the massive rocks of this region.

The demand for Portland cement in the Philippines is naturally affected by the cost of concrete materials. Until recently the cost of sand, gravel, and crushed stone has been very high, and the character of the material comparatively poor. Within the last year Adams [a] has published the results of a geological reconnoissance of southwest Luzon in so far as they relate to materials of construction. This report discusses the nature of the materials commonly used, shows where other and better ones may be obtained, and indicates their relative efficiencies in concrete construction. During this reconnoissance an extensive deposit of superior sand was discovered in Orani River, and this sand has now been introduced into use in Manila. A new site, near Angona, has been chosen for a city quarry, and the rock is regarded as superior to any that has been used heretofore, especially for macadamizing roads. If supplies of concrete material become cheaper as a result of these investigations the market for Portland cement in the Philippines should be strengthened.

Consumption of cement in the Philippines.—The quantity of cement (unclassified, but mainly Portland) imported into the Philippine Islands during the fiscal year ending June 30, 1909, is reported [b] as 99,793,334 pounds, or 262,814 barrels of 380 pounds each. Of this total, 84,797 barrels were government free entries and 31,111 barrels were railway free entries.

The commercial imports of 146,706 barrels were valued at an average of $1.686 per barrel. About 80 per cent of the commercial imports came from the Green Island Cement Company, at Hongkong, China, which produces Portland cement. Germany furnished nearly 10 per cent, the United Kingdom about 5.5 per cent, Belgium about 4 per cent, and the remainder was imported from Japan, Russia, the Netherlands, British East India, the United States, and France, in the order named. Another authority [c] reports that during the twelve months ending December, 1909, there were shipped from the United States to the Philippines 11,002 barrels of cement, valued at $12,420, an average value of about $1.13 per barrel.

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[a] Adams, George I., Sand, gravel, and crushed stone available for concrete construction in Manila: Philippine Jour. Sci., September, 1909, pp. 463-479.

[b] Communication from U. S. War Department, Bureau of Insular Affairs; Statistics from customs reports.

[c] Department of Commerce and Labor, Bureau of Statistics: Monthly Summary of Commerce and Finance in the United States, December, 1909, p. 1077.

CEMENT IN CANADA.

According to the preliminary report on the mineral production of Canada during the calendar year 1910, issued by the Canada department of mines, mines branch, February 23, 1911, the total quantity of Portland cement made in Canada in 1909 was 4,067,709 barrels, as compared with 3,495,961 barrels in 1908, an increase of 571,748 barrels, or 16 per cent. The average price per barrel at the mills in 1909 was $1.31, as compared with $1.39 in 1908. A 350-pound barrel is the standard in Canada. The imports of Portland cement into Canada in 1909 were 142,194 barrels of 350 pounds, at an average price per barrel of $1.17. The imports in 1908 were more than three times as great, or 469,049 barrels, averaging $1.13 per barrel. The imports of Portland cement into Canada have decreased rapidly during the last five years, 41 per cent of the whole consumption having been imported in 1905, and only 3 per cent having been imported in 1909. The duty on cement imported into the Dominion is 12½ cents per hundredweight. There is very little cement exported from Canada, so that the consumption in Canada is practically represented by the sales, together with the imports. In 1909 there were reported to be about 18 completed Portland cement plants in Canada.

During the year a large merger was effected among the manufacturers of Portland cement. A new concern, the Canada Cement Company, with a capital of $30,000,000, has assumed control of the producing plants at 10 points, extending from St. Lawrence River to the Rocky Mountains. The object of the merger is reported to be to eliminate the present excessive freight charges by distribution from the plant nearest the demand, and to do without competive salesmen—or, in short, to effect economies that will render the production of cement more profitable to the manufacturers. The plants included in this combination are among the best constructed and most efficiently equipped in Canada, and are reported to have an annual capacity of 4,500,000 barrels. This is in excess of the present production of Canada. There are at present six or eight plants outside the combination, and five or six more independent plants are planned to be built within the next few years.

SURVEY PUBLICATIONS ON CEMENT AND CEMENT AND CONCRETE MATERIALS.

The following list includes the principal publications on cement materials by the United States Geological Survey, or by members of its staff. The government publications, except those to which a price is affixed, can be obtained free by applying to the Director, United States Geological Survey, Washington, D. C. The priced publications may be purchased from the Superintendent of Documents, Government Printing Office, Washington, D. C.

Adams, G. I., and others. Economic geology of the Iola quadrangle, Kansas. Bulletin 238. 80 pp. 1904.

Ball, S. H. Portland cement materials in eastern Wyoming. In Bulletin 315, pp. 232–244. 1907.

Bassler, R. S. Cement materials of the Valley of Virginia. In Bulletin 260, pp. 531–544. 1905. 40c.

Burchard, E. F. Portland cement materials near Dubuque, Iowa. In Bulletin 315, pp. 225–231. 1907.

——— Concrete materials produced in the Chicago district. In Bulletin 340, pp. 383–410. 1908.

Burchard, E. F. Structural materials available in the vicinity of Austin, Tex. In Bulletin 420. 1910.

Butts, C. Sand-lime brick making near Birmingham, Ala. In Bulletin 315, pp. 256-258. 1907.

——— Ganister in Blair County, Pa. In Bulletin 380, pp. 337-342. 1909.

Catlett, C. Cement resources of the Valley of Virginia. In Bulletin 225, pp. 457-461. 1904. 35c.

Clapp, F. G. Limestones of southwestern Pennsylvania. Bulletin 249. 52 pp. 1905.

Crider, A. F. Cement resources of northeast Mississippi. In Bulletin 260, pp. 510-521. 1905. 40c.

——— Geology and mineral resources of Mississippi. Bulletin 283. 99 pp. 1906.

Darton, N. H. Geology and water resources of the northern portion of the Black Hills and adjoining regions in South Dakota and Wyoming. Professional Paper 65. 104 pp. 1909.

——— Structural materials in parts of Oregon and Washington. Bulletin 387. 36 pp. 1909.

Darton, N. H., and Siebenthal, C. E. Geology and mineral resources of the Laramie Basin, Wyoming. Bulletin 364. 81 pp. 1908.

Duryee, E. Cement investigations in Arizona. In Bulletin 213, pp. 372-380. 1903. 25c.

Eckel, E. C. The materials and manufacture of Portland cement. In Senate Doc. 19, 58th Cong., 1st sess., pp. 2-11. 1903.

——— Cement-rock deposits of the Lehigh district. In Bulletin 225, pp. 448-450. 1904. 35c.

——— Cement materials and cement industries of the United States. Bulletin 243. 395 pp. 1905. Edition exhausted. Available in libraries of cities and educational institutions.

——— The American cement industry. In Bulletin 260, pp. 496-505. 1905. 40c.

——— Portland cement resources of New York. In Bulletin 260, pp. 522-530. 1905. 40c.

——— Cement resources of the Cumberland Gap district, Tennessee-Virginia. In Bulletin 285, pp. 374-376. 1906. 60c.

——— Cement industry in the United States in 1908. In Mineral Resources U. S. for 1908, pt. 2, pp. 441-453. 1909.

Eckel, E. C., and Crider, A. F. Geology and cement resources of the Tombigbee River district, Mississippi-Alabama. Senate Doc. 165, 58th Cong., 3d sess. 21 pp. 1905.

Humphrey, R. L. The effects of the San Francisco earthquake and fire on various structures and structural materials. In Bulletin 324, pp. 14-61. 1907. 50c.

——— Organization, equipment, and operation of the structural-materials testing laboratories at St. Louis, Mo. Bulletin 329. 85 pp. 1908.

——— Portland cement mortars and their constituent materials: Results of tests, 1905 to 1907. Bulletin 331. 130 pp. 1908.

——— The strength of concrete beams; results of tests made at the structural-materials testing laboratories. Bulletin 344. 59 pp. 1908.

——— The fire-resistive properties of various building materials. Bulletin 370. 99 pp. 1909.

Landes, H. Cement resources of Washington. In Bulletin 285, pp. 377-383. 1906. 60c.

Martin, G. C. The Niobrara limestone of northern Colorado as a possible source of Portland cement material. In Bulletin 380, pp. 314-326. 1909.

Pepperberg, L. J. Cement material near Havre, Mont. In Bulletin 380, pp. 327-336. 1909.

Richardson, G. B. Portland cement materials near El Paso, Tex. In Bulletin 340, pp. 411-414. 1908.

Russell, I. C. The Portland cement industry in Michigan. In Twenty-second Ann. Rept., pt. 3, pp. 620-686. 1902.

Sewell, J. S. The effects of the San Francisco earthquake on buildings, engineering structures, and structural materials. In Bulletin 324, pp. 62-130. 1907. 50c.

Smith, E. A. The Portland cement materials of central and southern Alabama. In Senate Doc. 19, 58th Cong., 1st sess., pp. 12-23. 1903.

——— Cement resources of Alabama. In Bulletin 225, pp. 424-447. 1904. 35c.

Taff, J. A. Chalk of southwestern Arkansas, with notes on its adaptability to the manufacture of hydraulic cements. In Twenty-second Ann. Rept., pt. 3, pp. 687-742. 1902.

CLAY-WORKING INDUSTRIES.

By Jefferson Middleton.

INTRODUCTION.

With the exception of the section on clay production, this report deals with the products of the clay-working industries, and hence the tables are made up to show the products of clay manufactured and not the production of clay.

The year 1909 in the clay-working industries was a remarkable one. The industries were in a very prosperous condition and the value of the product was the largest ever made, the total being $166,321,213, an increase of $33,123,451, or 24.87 per cent, as compared with $133,197,762 in 1908, and an increase of $7,378,844, or 4.64 per cent, as compared with $158,942,369 in 1907. The decrease in 1908, $25,744,607, the result of the general financial depression, was the largest recorded.

Of the two great divisions of the industry, (*a*) brick and tile and (*b*) pottery, the former appears to have been slightly more prosperous than the latter, the increase being 25.18 per cent and 23.53 per cent, respectively. In the brick and tile industry every item except fancy brick, sewer pipe, and stove lining increased in value. Of these three, only one, sewer pipe, is an important factor in the industry, and the reason for the decrease in that item is the difference of basis on which the figures were compiled, the sales being taken as the basis for 1908 and the manufactured product for 1909. In the pottery industry every product showed an increase in value. The imports of pottery showed a gain of less than 1 per cent, although the product gained 23.53 per cent, and the proportion of the domestic product to consumption, 76.19 per cent, was the highest ever recorded. The exports of high-grade domestic pottery though small showed an increase, and the exports of all clay products increased 22.24 per cent.

Not only was 1909 a year of prosperity in the clay-working industries but it was notable for the introduction of some important improvements. The most prominent of them is the brick-setting machine introduced in the West. The idea of handling brick by machinery originated in New England and a plant was equipped several years ago with an elaborate system and was the first to use the "unit stack." By this system the unit for handling was 1,500 brick. This plant was destroyed by fire and was never rebuilt. In 1909 a system of handling from 600 to 1,000 bricks on a somewhat different plan was put into successful operation in the West and is now being used in Chicago. By this system it is possible for the brick to be carried from the molding machine to the drier, from the drier to the kiln, and from the kiln to the stock yard or the delivery car or cart without being touched by hand. Each of these machines is said to do the work of 40 men.

More and more attention is being given to the preparation of the clay by weathering, mixing, grinding, screening, and tempering before it is passed through the molding machine. It has been found that the quality of the product is much improved by better preparation of the clay.

The enormous fire tax on the people of this country imposed by flimsy and inflammable buildings, as shown in Bulletin 418 of this Survey, has aroused public sentiment on the subject of fireproof construction, and as a result the demand for fireproof structures is increasing, and the growing use of brick and other burned-clay products has been the natural consequence. The use of hollow building tile or block for outer walls seems to be on the increase. Some very attractive architectural effects have been produced with this tile in combination with brick and with stuccoed outer surfaces. Improvements in front brick, both in texture and in color, have been attained within the last few years and have enhanced the value of this product as a building material.

The number of operating firms continues to decline. A few years ago there were scattered throughout the country many small plants, but the present tendency is to concentrate the industry and to build plants with high-grade equipment and large capacity. The average value of the output per firm reporting in 1900 was $14,859; in 1909 it was $32,818. The capacity of brick machinery has been greatly increased in recent years. A few years ago a machine that would make 5,000 or 6,000 brick an hour was considered a wonder. To-day machines are in operation that will turn out three times as many brick.

The great tendency in the clay-working industries is to reduce the cost of production by the use of more efficient machinery and by the elimination, as far as possible, of hand labor.

The figures in this report for 1909 were obtained by the Survey in cooperation with the Bureau of the Census. The collection of statistics by personal visits of agents and the use of manufactured output rather than of marketed product as the basis of compilation are different from the methods usually employed by the Survey. It was thought that the collection of data by personal visits instead of by mail would greatly expedite the work, but experience has not demonstrated the truth of this theory. In the clay-working industries, where large stocks are not generally carried over from season to season, the change of the basis of compilation is not believed to have made any appreciable difference in the figures presented except in the case of sewer pipe.

ACKNOWLEDGMENTS.

This opportunity is taken to express the appreciation of the writer for the uniform courtesy extended by Mr. W. M. Steuart, chief statistician, division of manufactures, Bureau of the Census, and by other officials of that bureau, and especially for their interest in the work and their efforts to expedite it.

PRODUCTION.

In the following table will be found a statement of the value of the clay products of the United States in 1908 and 1909:

Value of the products of clay in the United States in 1908 and 1909, by States and Territories.

State or Territory.	1908.			1909.		
	Brick and tile.	Pottery.	Total.	Brick and tile.	Pottery.	Total.
Alabama	$1,535,517	$24,089	$1,559,606	$1,663,788	$36,339	$1,700,127
Arizona	104,992		104,992	107,940		107,940
Arkansas	481,288	27,500	508,788	600,550	26,474	627,024
California	4,436,619	87,126	4,523,745	4,312,590	124,575	4,437,165
Colorado	1,920,674	49,407	1,970,081	1,994,798	54,226	2,049,024
Connecticut and Rhode Island	825,561	a 76,000	901,561	1,515,595	(a)	1,515,595
Delaware	146,527		146,527	231,505		231,505
District of Columbia	268,600	(b)	268,600	214,489	(b)	214,489
Florida	233,162		233,162	298,620		298,620
Georgia	1,917,960	10,651	1,928,611	2,265,121	29,380	2,294,501
Idaho and Nevada	339,356		339,356	416,695		416,695
Illinois	10,752,160	806,954	11,559,114	13,505,898	838,555	14,344,453
Indiana	5,979,677	760,490	6,740,167	6,744,295	900,928	7,645,223
Iowa	4,050,787	18,710	4,069,497	4,846,706	51,990	4,898,696
Kansas	2,248,805	(b)	2,248,805	2,709,822	(b)	2,709,822
Kentucky	2,085,460	153,648	2,239,108	2,332,475	146,397	2,478,872
Louisiana	623,753	6,171	629,924	528,261	(b)	528,261
Maine	542,730	(b)	542,730	635,667	(b)	635,667
Maryland	1,165,412	275,687	1,441,099	1,400,380	320,432	1,720,812
Massachusetts	1,397,636	249,726	1,647,362	1,631,858	256,028	1,887,886
Michigan	1,666,381	62,409	1,728,790	1,947,059	95,439	2,042,498
Minnesota	1,508,710	(b)	1,508,710	1,755,438	(b)	1,755,438
Mississippi	806,889	21,850	828,739	779,009	19,341	798,350
Missouri	5,562,548	68,908	5,631,456	7,367,061	73,122	7,440,183
Montana	387,525	(b)	387,525	451,389	(b)	451,389
Nebraska	946,516		946,516	1,146,449		1,146,449
New Hampshire	371,640	(b)	371,640	552,215	(b)	552,215
New Jersey	6,363,705	5,949,991	12,313,696	9,380,958	7,791,136	17,172,094
New Mexico	140,671	(b)	140,671	182,755	(b)	182,755
New York	7,270,981	1,658,243	8,929,224	10,270,227	1,887,209	12,157,436
North Carolina	930,606	13,362	943,968	1,283,902	18,709	1,302,611
North Dakota	206,222		206,222	269,324		269,324
Ohio	15,915,703	10,706,787	26,622,490	16,929,885	13,416,356	30,346,241
Oklahoma	562,929		562,929	1,032,314		1,032,314
Oregon	555,768	(b)	555,768	827,963	(b)	827,963
Pennsylvania	13,566,479	1,276,503	14,842,982	19,403,944	1,782,769	21,186,713
Porto Rico	(c)	(c)	(c)	34,506	(b)	34,506
South Carolina	606,779	8,469	615,248	751,037	1,967	753,004
South Dakota	63,847		63,847	68,660		68,660
Tennessee	1,123,802	112,632	1,236,434	1,575,262	73,610	1,648,872
Texas	1,941,589	125,146	2,066,735	3,026,035	122,428	3,148,463
Utah	655,067	3,450	658,517	874,159	(b)	874,159
Vermont	89,064		89,064	83,360		83,360
Virginia	1,499,130	(b)	1,499,130	1,919,771	36,746	1,956,517
Washington	2,083,688	20,601	2,104,289	3,044,275	16,211	3,060,486
West Virginia	1,177,915	2,083,821	3,261,736	1,159,627	2,350,470	3,510,097
Wisconsin	949,095	9,300	958,395	1,130,380	9,209	1,139,589
Wyoming	52,282		52,282	67,755		67,755
Other States		467,924	467,924		569,395	569,395
Total	108,062,207	25,135,555	133,197,762	135,271,772	31,049,441	166,321,213
Per cent of total	81.13	18.87	100.00	81.33	18.67	100.00

a Produced by Connecticut alone, and for the year 1909 included in "Other States."
b Included in "Other States."
c Statistics for Porto Rico were not collected prior to 1909.

Of the total value, $166,321,213 for 1909, the brick and tile, the materials which are used in the structural and engineering arts, was valued at $135,271,772, or 81.33 per cent, and the pottery was valued at $31,049,441, or 18.67 per cent. These relative percentages have been maintained a number of years. In 1907 the value of the brick and tile was $128,798,895, or 81.03 per cent, and of the pottery $30,143,474, or 18.97 per cent. Every State and Territory except Alaska is a producer of burned clay, and Porto Rico appeared in 1909 as a producer for the first time. In Nevada and Rhode Island there was not a sufficient number of producers to permit the publication of State totals without disclosing individual returns, so that the returns for these States have been combined with those of contiguous States.

Value of the clay products of the United States, by States and Territories, in 1908 and 1909, showing increase or decrease, with percentage of increase or decrease.

State or Territory.	1908.	1909.	Increase (+) or decrease (−) in 1909.	Percentage of increase (+) or decrease (−) in 1909.
Alabama	$1,559,606	$1,700,127	+ $140,521	+ 9.01
Arizona	104,992	107,940	+ 2,948	+ 2.81
Arkansas	508,788	627,024	+ 118,236	+23.24
California	4,523,745	4,437,165	− 86,580	− 1.91
Colorado	1,970,081	2,049,024	+ 78,943	+ 4.01
Connecticut and Rhode Island	901,561	1,515,595	+ 614,034	+68.11
Delaware	146,527	231,505	+ 84,978	+57.99
District of Columbia	268,600	214,489	− 54,111	−20.15
Florida	233,162	298,620	+ 65,458	+28.07
Georgia	1,928,611	2,294,501	+ 365,890	+18.97
Idaho and Nevada	339,356	416,695	+ 77,339	+22.79
Illinois	11,559,114	14,344,453	+ 2,785,339	+24.10
Indiana	6,740,167	7,645,223	+ 905,056	+13.43
Iowa	4,069,497	4,898,696	+ 829,199	+20.38
Kansas	2,248,805	2,709,822	+ 461,017	+20.50
Kentucky	2,239,108	2,478,872	+ 239,764	+10.71
Louisiana	629,924	528,261	− 101,663	−16.14
Maine	542,730	635,667	+ 92,937	+17.12
Maryland	1,441,099	1,720,812	+ 279,713	+19.41
Massachusetts	1,647,362	1,887,886	+ 240,524	+14.60
Michigan	1,728,790	2,042,498	+ 313,708	+18.15
Minnesota	1,508,710	1,755,438	+ 246,728	+16.35
Mississippi	828,739	798,350	− 30,389	− 3.67
Missouri	5,631,456	7,440,183	+ 1,808,727	+32.12
Montana	387,525	451,389	+ 63,864	+16.48
Nebraska	946,516	1,146,449	+ 199,933	+21.12
New Hampshire	371,640	552,215	+ 180,575	+48.59
New Jersey	12,313,696	17,172,094	+ 4,858,398	+39.46
New Mexico	140,671	182,755	+ 42,084	+29.92
New York	8,929,224	12,157,436	+ 3,228,212	+36.15
North Carolina	943,968	1,302,611	+ 358,643	+37.99
North Dakota	206,222	269,324	+ 63,102	+30.60
Ohio	26,622,490	30,346,241	+ 3,723,751	+13.99
Oklahoma	562,929	1,032,314	+ 469,385	+83.38
Oregon	555,768	827,963	+ 272,195	+48.98
Pennsylvania	14,842,982	21,186,713	+ 6,343,731	+42.74
Porto Rico	(a)	34,506	34,506	....
South Carolina	615,248	753,004	+ 137,756	+22.39
South Dakota	63,847	68,660	+ 4,813	+ 7.54
Tennessee	1,236,434	1,648,872	+ 412,438	+33.36
Texas	2,066,735	3,148,463	+ 1,081,728	+52.34
Utah	658,517	874,159	+ 215,642	+32.75
Vermont	89,064	83,360	− 5,704	− 6.40
Virginia	1,499,130	1,956,517	+ 457,387	+30.51
Washington	2,104,289	3,060,486	+ 956,197	+45.44
West Virginia	3,261,736	3,510,097	+ 248,361	+ 7.61
Wisconsin	958,395	1,139,589	+ 181,194	+18.91
Wyoming	52,282	67,755	+ 15,473	+29.60
Other States	b 467,924	b 569,395	+ 101,471	+21.69
Total	133,197,762	166,321,213	+33,123,451	+24.87

a Statistics for Porto Rico not collected prior to 1909.
b Includes pottery products which could not be separately classified without disclosing individual figures.

Of the States and Territories represented by the 48 totals, 5 showed losses, 42 showed gains, and 1 (Porto Rico), appearing in 1909 for the first time as a producer, shows only a small output. These losses, which amounted to only $278,447, were insignificant, the largest, $101,663, being in Louisiana, and the smallest, $5,704, in Vermont. In 1908 only 8 States showed gains and 39 showed losses. The gains in 1909 ranged from $2,948 in Arizona to $6,343,731 in Pennsylvania. The smallest proportionate increase was in Arizona, 2.81 per cent, and the largest in Oklahoma, 83.38 per cent.

In the following table will be found a comparison of the several varieties of clay products in 1908 and 1909, showing the actual gain or loss in each variety and the percentage of gain or loss:

Value of the products of clay in the United States in 1908 and 1909, with increase or decrease.

Product.	1908.	1909.	Increase (+) or decrease (−) in 1909.	Percentage of increase (+) or decrease (−) in 1909.
Common brick	$44,765,614	$57,251,115	+$12,485,501	+27.89
Vitrified paving brick or block	10,657,475	11,269,586	+ 612,111	+ 5.74
Front brick	6,935,600	9,712,219	+ 2,776,619	+40.03
Fancy or ornamental brick	259,556	174,073	− 85,483	−32.93
Enameled brick	660,862	993,902	+ 333,040	+50.39
Drain tile	8,661,476	9,799,158	+ 1,137,682	+13.13
Sewer pipe	11,003,731	10,322,324	− 681,407	− 6.19
Architectural terra cotta	4,577,367	6,251,625	+ 1,674,258	+36.58
Fireproofing	3,168,037	4,466,708	+ 1,298,671	+40.99
Tile (not drain)	3,877,780	5,291,963	+ 1,414,183	+36.47
Stove lining	529,976	423,583	− 106,393	−20.08
Fire brick	10,696,216	16,620,695	+ 5,924,479	+55.39
Miscellaneous	2,268,517	2,694,821	+ 426,304	+18.80
Total brick and tile	108,062,207	135,271,772	+ 27,209,565	+25.18
Total pottery	25,135,555	31,049,441	+ 5,913,886	+23.53
Grand total	133,197,762	166,321,213	+ 33,123,451	+24.87

This table shows that only three items sustained losses in 1909, only one of which, sewer pipe, may be considered of importance. In 1908 only two items, vitrified brick and drain tile, showed gains.

The greatest of all clay products in point of value and geographic distribution, common brick, showed a large gain, $12,485,501, or 27.89 per cent, in 1909 over 1908; vitrified paving brick showed the smallest proportionate gain, 5.74 per cent, in 1909, although in 1908 it increased 10.39 per cent, and in 1907, 22.86 per cent.

Drain tile gained $1,137,682, or 13.13 per cent; in 1908 its increase was $1,797,314, or 26.18 per cent. Its principal field of usefulness is the Middle West, though its use is increasing in the South.

Sewer pipe is the only product of importance to show a loss in 1909, although this loss was probably not so great as it appears to be. This industry is the only one of the clay-working industries in which stocks of any size are carried on hand. As the schedules of the Census Office called for manufactured product and the Survey's figures for 1908 were for sales, the decrease may be accounted for, as has already been suggested, by this change of basis of valuation.

Fire brick, next to common brick, was the brick and tile product of greatest value and showed the largest proportional gain in 1909, as it had shown the largest proportional loss in 1908. This large gain was partly due to the inclusion of silica brick in the 1909 product. Silica brick, however, was valued at probably not more than 10 per cent of the whole, so that there was still a large increase in fire brick in 1909.

The increase was: Brick and tile, $27,209,565, or 25.18 per cent, and pottery, $5,913,886, or 23.53 per cent, a total of $33,123,451, or 24.87 per cent. In 1908 the total decrease was $25,744,607, or 16.20 per cent.

The following table shows the value of the products of clay in the United States from 1900 to 1909, inclusive, by variety of product, together with the total for each year and the number of operating firms reporting:

Products of clay in the United States, 1900–1909, by varieties.

Year.	Number of operating firms reporting.	Common brick.			Vitrified paving brick.		
		Quantity (thousands).	Value.	Average value per thousand.	Quantity (thousands).	Value.	Average value per thousand.
1900	6,475	7,140,622	$38,621,514	$5.41	546,679	$4,764,124	$8.71
1901	6,421	8,038,579	45,503,076	5.66	605,077	5,484,134	9.06
1902	6,046	8,475,067	48,885,869	5.77	617,192	5,744,530	9.31
1903	6,034	8,463,683	50,532,075	5.97	654,499	6,453,849	9.86
1904	6,108	8,665,171	51,768,558	5.97	735,489	7,557,425	10.28
1905	5,925	9,817,355	61,394,383	6.25	665,879	6,703,710	10.07
1906	5,857	10,027,039	61,300,696	6.11	751,974	7,857,768	10.45
1907	5,536	9,795,698	58,785,461	6.00	876,245	9,654,282	11.02
1908	5,328	7,811,046	44,765,614	5.73	978,122	10,657,475	10.90
1909	5,068	9,791,870	57,251,115	5.85	1,023,654	11,269,586	11.01

Year.	Front brick.			Fancy or ornamental brick (value).	Enameled brick (value).	Fire brick (value).	Stove lining (value).	Drain tile (value).
	Quantity (thousands).	Value.	Average value per thousand.					
1900	344,516	$3,864,670	$11.09	$289,698	$323,630	$9,830,517	$462,541	$2,976,281
1901	415,343	4,709,737	11.34	372,131	463,709	9,870,421	423,371	3,143,001
1902	458,391	5,318,008	11.60	335,290	471,163	11,970,511	630,924	3,506,787
1903	433,016	5,402,861	12.48	328,387	569,689	[a] 14,062,369	([a])	4,639,214
1904	434,351	5,560,131	12.80	300,233	545,397	11,167,972	([a])	5,348,555
1905	541,590	7,108,092	13.12	293,907	636,279	12,735,404	645,432	5,850,210
1906	617,469	7,895,323	12.79	207,119	773,104	14,206,868	743,414	6,543,289
1907	585,943	7,329,360	12.51	361,243	918,173	14,946,045	627,647	6,864,162
1908	584,482	6,935,600	11.87	259,556	660,862	10,696,216	529,976	8,661,476
1909	816,164	9,712,219	11.90	174,073	993,902	16,620,695	423,583	9,799,158

Year.	Sewer pipe (value).	Architectural terra cotta (value).	Fireproofing (value).	Tile, not drain (value).	Miscellaneous (value).	Total brick and tile (value).	Pottery (value).	Total value.
1900	$5,842,562	$2,372,568	$1,820,214	$2,349,420	$2,896,036	$76,413,775	$19,798,570	$96,212,345
1901	6,736,969	3,367,982	1,860,269	2,867,659	2,945,268	87,747,727	22,463,860	110,211,587
1902	7,174,892	3,526,906	3,175,593	3,622,863	3,678,742	98,042,078	24,127,453	122,169,531
1903	8,525,369	4,672,028	3,861,343	3,505,329	3,073,856	105,626,369	25,436,052	131,062,421
1904	9,187,423	4,107,473	3,629,101	3,023,428	3,669,282	105,864,978	25,158,270	131,023,248
1905	10,097,089	5,003,158	4,098,793	3,647,726	3,564,111	121,778,294	27,918,894	149,697,188
1906	11,114,967	5,739,460	4,586,538	4,634,898	3,988,394	129,591,838	31,440,884	161,032,722
1907	11,482,845	6,026,977	4,250,618	4,551,881	3,000,201	128,798,895	30,143,474	158,942,369
1908	11,003,731	4,577,367	3,168,037	3,877,780	2,268,517	108,062,207	25,135,555	133,197,762
1909	10,322,324	6,251,625	4,466,708	5,291,963	2,694,821	135,271,772	31,049,441	166,321,213

[a] Stove lining is included in fire brick in 1903; in miscellaneous in 1904.

This table shows the growth of the clay-working industries during ten years. The total value of these products increased from $96,212,345 in 1900 to $166,321,213 in 1909. In only three years has there been a decrease, and in one, 1904, the decrease was so small, $39,173, as to be negligible. In 1908 the greatest decrease and in 1909 the greatest increase was recorded. The difference between the maximum and the minimum—the increase of the value of the clay products in ten years—was $70,108,868, or 72.87 per cent. The maximum value was reached in 1909 in seven products—vitrified paving brick, front brick, enameled brick, fire brick, drain tile, architectural terra cotta, and tile (not drain).

The maximum quantity of common brick was reached in 1906, and the maximum value in 1905; the production of 1909 was within 235,169,000 brick, or 2.35 per cent, and the value within $4,143,268, or 6.75 per cent, of the respective maximum. The average price per thousand ranged from $5.41 in 1900 to $6.25 in 1905.

Vitrified paving brick has shown a steady increase in quantity and value of product since 1900, except in 1905, and was one of the two products that showed a gain in 1908. It reached its maximum in 1909. The gain in the ten years in the value of this product was 136.55 per cent.

Front brick increased steadily in value from 1900 to 1906, inclusive; then for two years it fell off, but showed the largest value yet recorded in 1909. The price per thousand ranged from $11.09 in 1900 to $13.12 in 1905, since which date it has declined gradually to $11.87 in 1908 and $11.90 in 1909.

Enameled brick showed a three-fold increase in the ten years from $323,630 in 1900 to $993,902 in 1909.

Fire brick increased in value from $9,830,517 in 1900 to $16,620,695 in 1909, or 69.07 per cent.

Drain tile is the only product that has shown steady gain throughout the ten years covered by the table, the increase in value in the ten years being $6,822,877, or 229.24 per cent.

Sewer pipe showed a steady gain from 1900 to 1908, when it fell off $479,114, or 4.17 per cent, and made a still further decline in 1909.

Architectural terra cotta showed an almost continuous growth, declining only in 1904 and 1908 and reaching its maximum value in 1909.

Fireproofing is growing in importance. Its maximum value was attained in 1906, but the output in 1909 was within $119,830, or 2.61 per cent, of this maximum. The gain in 1909 was $1,298,671, or 40.99 per cent.

Tile, not drain, has varied more or less, but showed a large gain in 1909 and reached its maximum in that year.

RANK OF STATES.

The following table shows the rank of States in value of clay products, the number of operating firms reporting, and the percentage of the total value produced by each State:

Rank of States, value of output, and percentage of total value of clay products in 1908 and 1909.

State.	1908.				1909.			
	Rank.	Number of operating firms reporting.	Value.	Percentage of total product.	Rank.	Number of operating firms reporting.	Value.	Per centage of total product.
Ohio	1	706	$26,622,490	19.99	1	685	$30,346,241	18.25
Pennsylvania	2	466	14,842,982	11.14	2	457	21,186,713	12.74
New Jersey	3	165	12,313,696	9.24	3	165	17,172,094	10.32
Illinois	4	400	11,559,114	8.68	4	379	14,344,453	8.62
New York	5	241	8,929,224	6.70	5	243	12,157,436	7.31
Indiana	6	369	6,740,167	5.06	6	348	7,645,223	4.60
Missouri	7	161	5,631,456	4.23	7	156	7,440,183	4.47
Iowa	9	263	4,069,497	3.06	8	247	4,898,696	2.95
California	8	119	4,523,745	3.40	9	99	4,437,165	2.67
West Virginia	10	60	3,261,736	2.45	10	50	3,510,097	2.11
Texas	14	122	2,066,735	1.55	11	113	3,148,463	1.89
Washington	13	67	2,104,289	1.58	12	65	3,060,486	1.84
Kansas	11	65	2,248,805	1.69	13	58	2,709,822	1.63
Kentucky	12	116	2,239,108	1.68	14	99	2,478,872	1.49
Georgia	16	108	1,928,611	1.45	15	105	2,294,501	1.38
Colorado	15	80	1,970,081	1.48	16	73	2,049,024	1.23
Michigan	17	132	1,728,790	1.30	17	122	2,042,498	1.23
Virginia	21	80	1,499,130	1.13	18	89	1,956,517	1.18
Massachusetts	18	76	1,647,362	1.24	19	72	1,887,886	1.14
Minnesota	20	92	1,508,710	1.13	20	80	1,755,438	1.06
Maryland	22	65	1,441,099	1.08	21	59	1,720,812	1.03
Alabama	19	103	1,559,606	1.17	22	100	1,700,127	1.02
Tennessee	23	104	1,236,434	.93	23	100	1,648,872	.99
Connecticut and Rhode Island	27	41	901,561	.68	24	42	1,515,595	.91
North Carolina	26	216	943,968	.71	25	187	1,302,611	.78
Nebraska	25	90	946,516	.71	26	79	1,146,449	.69
Wisconsin	24	121	958,395	.72	27	106	1,139,589	.69
Oklahoma	32	33	562,929	.42	28	39	1,032,314	.62
Utah	29	47	658,517	.49	29	37	874,159	.53
Oregon	33	62	555,768	.42	30	68	827,963	.50
Mississippi	28	88	828,739	.62	31	79	798,350	.48
South Carolina	31	60	615,248	.46	32	52	753,004	.45
Maine	34	53	542,730	.41	33	49	635,667	.38
Arkansas	35	52	508,788	.38	34	50	627,024	.38
New Hampshire	37	30	371,640	.28	35	29	552,215	.33
Louisiana	30	62	629,924	.47	36	54	528,261	.32
Montana	36	28	387,525	.29	37	22	451,389	.27
Idaho and Nevada	38	51	339,356	.25	38	41	416,695	.25
Florida	40	22	233,162	.17	39	22	298,620	.18
North Dakota	41	18	206,222	.15	40	13	269,324	.16
Delaware	42	19	146,527	.11	41	22	231,505	.14
District of Columbia	39	12	268,600	.20	42	9	214,489	.13
New Mexico	43	16	140,671	.11	43	17	182,755	.11
Arizona	44	16	104,992	.08	44	20	107,940	.06
Vermont	45	11	89,064	.07	45	8	83,360	.05
South Dakota	46	10	63,847	.05	46	10	68,660	.04
Wyoming	47	10	52,282	.04	47	13	67,755	.04
Porto Rico	(a)	(a)	(a)	(a)	48	36	34,506	.02
Other States	......	....	b 467,924	.35	......	....	b 569,395	.34
Total	......	5,328	133,197,762	100.00	......	5,068	166,321,213	100.00

a Statistics for Porto Rico were not collected prior to 1909.
b Undistributed pottery products.

The value of the clay products ranged by States in 1909 from 34,506, or 0.02 of 1 per cent, in Porto Rico, to $30,346,241, or 18.25 er cent in Ohio. Ohio has been the leading clay-working State in he Union since figures were compiled by this office, and probably vill be for years to come. The value of Ohio's output in 1909 was 9,159,528, or 43.23 per cent, greater than that of Pennsylvania, he second State, whose output was valued at $21,186,713, or 12.74 er cent of the total. New Jersey was third in both years, reporting .24 per cent of the total in 1908 and 10.32 per cent of it in 1909. 'here was no change in the relative rank of the first seven States. owa, which was ninth in 1908 was eighth in 1909, exchanging places vith California; Texas rose from fourteenth in 1908 to eleventh in 909, and Washington from thirteenth to twelfth; Kansas fell from leventh to thirteenth, and Kentucky from twelfth to fourteenth. 'irginia rose from twenty-first to eighteenth; Oklahoma rose from hirty-second to twenty-eighth; and Louisiana fell from thirtieth o thirty-sixth.

The first ten States reported for 1909 wares valued at $123,138,301, r 74.04 per cent of the total; for 1908, $98,494,107, or 73.95 per cent f the total. The first five reported wares in 1909 valued at 95,206,937, or 57.24 per cent of the total, compared with $74,267,- 06, or 55.75 per cent of the total, in 1908.

The number of firms reporting continues to show a decrease, alling from 5,328 in 1908 to 5,068 in 1909, a decrease of 260. No ttempt is made to show the number of yards or plants, but merely he number of operating firms reporting. The number of plants is onsiderably greater than the number of firms, as many firms have nore than one plant and some as many as 25; nor are any idle lants included, the number of which was considerable in 1909.

BRICK AND TILE.

PRODUCTION.

The tables following show the output and value of the building rick and other structural products of clay, and of the fire brick, aving brick, and other clay products used in engineering work, the ank of the States in these products, and the percentage of the total alue of each State in 1908 and 1909.

Brick and tile products in the United States in 1908.

Rank.	State.	Common brick. Quantity.	Common brick. Value.	Common brick. Average price per thousand.	Vitrified brick or block. Quantity.	Vitrified brick or block. Value.	Vitrified brick or block. Average price per thousand.
		Thousands.			*Thousands.*		
17	Alabama	120,237	$690,963	$5.75	18,248	$244,084	$13.38
44	Arizona	11,282	104,042	9.22	...	...	...
35	Arkansas	57,885	389,617	6.73	(a)	(a)	7.09
8	California	236,383	1,593,814	6.74	3,499	66,214	18.92
14	Colorado	112,859	795,733	7.05	2,372	30,262	12.76
27	Connecticut and Rhode Island	131,760	749,093	5.69	(a)	(a)	16.25
42	Delaware	15,388	125,127	8.13	...	...	...
39	District of Columbia	23,931	177,503	7.42	...	...	...
40	Florida	38,559	225,441	5.85	...	...	...
15	Georgia	248,585	1,335,349	5.37	(a)	(a)	15.50
38	Idaho and Nevada	36,314	319,636	8.80	(a)	(a)	25.00
3	Illinois	1,119,224	4,834,652	4.32	138,362	1,622,496	11.73
6	Indiana	224,454	1,221,910	5.44	57,748	776,533	13.45
9	Iowa	135,678	904,308	6.67	16,672	185,112	11.10
10	Kansas	225,820	896,542	3.97	102,922	862,019	8.38
11	Kentucky	110,545	687,365	6.22	(a)	(a)	13.26
30	Louisiana	77,856	547,160	7.03	...	...	...
34	Maine	45,112	303,259	6.72	(a)	(a)	13.77
22	Maryland	141,071	828,981	5.88	(a)	(a)	13.06
20	Massachusetts	141,591	950,921	6.72	...	...	...
16	Michigan	181,049	994,525	5.49	6,165	76,630	12.43
18	Minnesota	145,712	869,532	5.97	(a)	(a)	9.00
28	Mississippi	112,999	748,052	6.62	...	...	...
7	Missouri	219,526	1,465,311	6.67	56,805	647,097	11.39
36	Montana	34,065	310,962	9.13	(a)	(a)	20.00
25	Nebraska	114,399	766,146	6.70	(a)	(a)	7.59
37	New Hampshire	50,372	365,400	7.25	...	...	...
5	New Jersey	300,544	1,579,835	5.26	(a)	(a)	11.43
43	New Mexico	11,292	90,498	8.01	(a)	(a)	10.07
4	New York	1,055,006	5,066,084	4.80	14,570	211,290	14.50
26	North Carolina	144,192	900,611	6.25	(a)	(a)	8.00
41	North Dakota	17,476	136,260	7.80	...	...	...
1	Ohio	369,410	2,105,910	5.70	327,718	3,232,335	9.86
32	Oklahoma	74,836	457,588	6.11	7,681	71,545	9.31
33	Oregon	43,732	373,008	8.53	...	...	...
2	Pennsylvania	717,016	4,539,978	6.33	90,044	1,038,254	11.53
31	South Carolina	96,827	573,572	5.92	...	...	...
46	South Dakota	5,893	57,247	9.71	...	...	...
23	Tennessee	134,171	767,773	5.72	(a)	(a)	11.46
13	Texas	194,551	1,285,857	6.61	(a)	(a)	10.81
29	Utah	48,645	351,827	7.23	...	...	...
45	Vermont	10,419	62,172	5.97	...	...	...
19	Virginia	185,738	1,219,946	6.57	...	...	...
12	Washington	107,638	817,962	7.60	(a)	(a)	19.82
21	West Virginia	47,402	300,776	6.35	70,924	718,017	10.12
24	Wisconsin	129,041	830,249	6.43	...	...	...
47	Wyoming	4,561	47,117	10.33	...	...	...
	Other States [b]	...	...	...	64,392	875,587	13.60
		7,811,046	44,765,614	5.73	978,122	10,657,475	10.90
	Per cent of brick and tile products	...	41.43	...	...	9.86	...
	Per cent of total of clay products	...	33.61	...	...	8.00	...

[a] Included in "Other States."
[b] Includes all products made by less than three producers in one State.

Brick and tile products in the United States in 1908—Continued.

Rank.	State.	Front brick. Quantity.	Front brick. Value.	Front brick. Average price per thousand.	Fancy or ornamental brick (value).	Drain tile (value).	Sewer pipe (value).	Architectural terra cotta (value).	Fireproofing (value).
		Thousands.							
17	Alabama	(*a*)	(*a*)	$17.89	(*a*)	$2,046	(*a*)	...	(*a*)
44	Arizona	(*a*)	(*a*)	17.27	...	...	...	...	...
35	Arkansas	460	$5,550	12.07	...	5,330	...	...	...
8	California	12,393	283,701	22.89	$34,947	34,457	$1,036,320	$500,130	$188,221
14	Colorado	31,667	364,367	11.51	34,777	16,472	(*a*)	(*a*)	(*a*)
27	Connecticut and Rhode Island	(*a*)	(*a*)	15.75	...	...	...	...	...
42	Delaware	(*a*)	(*a*)	13.00	...	(*a*)	...	...	...
39	District of Columbia	(*a*)	(*a*)	12.00	...	(*a*)	(*a*)	...	(*a*)
40	Florida	(*a*)	(*a*)	9.00	...	(*a*)	...	...	...
15	Georgia	2,929	34,385	11.74	...	(*a*)	253,664	(*a*)	(*a*)
38	Idaho and Nevada	827	17,600	21.28	...	...	...	...	...
3	Illinois	22,851	301,515	13.19	(*a*)	1,421,878	514,386	(*a*)	264,986
6	Indiana	34,336	403,545	11.75	(*a*)	1,797,329	486,946	(*a*)	359,817
9	Iowa	7,900	86,232	10.92	(*a*)	2,509,505	211,044	...	129,003
10	Kansas	29,477	233,578	7.92	(*a*)	22,359	(*a*)	(*a*)	(*a*)
11	Kentucky	11,067	119,785	10.82	...	53,308	(*a*)	...	7,263
30	Louisiana	2,991	36,792	12.30	...	(*a*)	...	...	...
34	Maine	1,640	13,950	8.51	(*a*)	3,758	(*a*)	...	...
22	Maryland	936	13,498	14.42	1,463	3,895	...	(*a*)	...
20	Massachusetts	1,899	34,055	17.93	(*a*)	...	...	...	(*a*)
16	Michigan	1,896	19,496	10.28	...	327,630	(*a*)	...	4,100
18	Minnesota	9,900	118,860	12.01	(*a*)	70,161	(*a*)	...	45,940
28	Mississippi	788	11,837	15.02	(*a*)	38,000	...	...	...
7	Missouri	32,136	356,758	11.10	25,035	76,865	962,116	(*a*)	105,136
36	Montana	(*a*)	(*a*)	20.00	(*a*)	(*a*)	(*a*)	...	(*a*)
25	Nebraska	(*a*)	(*a*)	13.99	(*a*)	12,346	...	...	63,191
37	New Hampshire	...	...	...	(*a*)	...	...	...	...
5	New Jersey	64,302	667,682	10.38	3,619	30,325	(*a*)	1,039,856	826,224
43	New Mexico	(*a*)	(*a*)	13.47	...	...	...	...	...
4	New York	9,721	135,342	13.92	(*a*)	275,681	133,716	709,360	122,395
26	North Carolina	300	2,700	9.00	...	1,635	(*a*)	...	(*a*)
41	North Dakota	4,159	63,975	15.38	(*a*)	(*a*)	...	...	(*a*)
1	Ohio	94,435	1,067,888	11.31	39,309	1,725,462	3,918,971	...	552,887
32	Oklahoma	1,231	16,010	13.01	(*a*)	(*a*)	...	...	...
33	Oregon	986	29,227	29.64	(*a*)	34,453	(*a*)	...	(*a*)
2	Pennsylvania	124,642	1,403,594	11.26	49,199	14,904	578,800	389,596	241,175
31	South Carolina	(*a*)	(*a*)	11.00	...	(*a*)	...	...	...
46	South Dakota	(*a*)	(*a*)	16.50	...	...	...	...	...
23	Tennessee	9,494	103,228	10.87	1,505	36,114	(*a*)	...	(*a*)
13	Texas	10,411	154,298	14.82	...	5,275	(*a*)	...	(*a*)
29	Utah	15,239	175,876	11.54	(*a*)	2,871	(*a*)	...	...
45	Vermont	...	...	...	...	(*a*)	...	...	...
19	Virginia	17,858	246,623	13.81	(*a*)	7,100	(*a*)	...	...
12	Washington	4,011	112,749	28.11	...	28,551	493,165	171,845	45,205
21	West Virginia	(*a*)	(*a*)	14.18	...	2,645	(*a*)	...	(*a*)
24	Wisconsin	4,646	41,569	8.95	(*a*)	74,702	...	...	(*a*)
47	Wyoming	354	5,165	14.59	...	...	...	...	...
	Other States [b]	16,600	254,170	15.31	69,702	26,419	2,414,603	1,766,580	212,494
		584,482	6,935,600	11.87	[c] 920,418	8,661,476	11,003,731	4,577,367	3,168,037
	Per cent of brick and tile products	...	6.42	...	.85	8.01	10.18	4.24	2.93
	Per cent of total of clay products	...	5.21	...	.69	6.50	8.26	3.44	2.38

[a] Included in "Other States."

[b] Includes all products made by less than three producers in one State.

[c] Includes enameled brick, valued at $660,862, made in the following States: California, Illinois, Maryland, Missouri, New Jersey, and Pennsylvania.

Brick and tile products in the United States in 1908—Continued.

Rank.	State.	Tile, not drain (value).	Stove lining (value).	Fire brick.			Miscellaneous (value).[a]	Total value.	Per centage of total value.
				Quantity.	Value.	Average price per thousand.			
				Thousands.					
17	Alabama			7,483	$122,354	$16.35	$10,616	$1,535,517	1.42
44	Arizona							104,992	.10
35	Arkansas			(b)	(b)	12.19		481,288	.44
8	California	$84,484	(b)	12,226	325,760	26.64	219,619	4,436,619	4.11
14	Colorado	(b)		10,195	206,161	20.22	167,967	1,920,674	1.78
27	Connecticut and Rhode Island		(b)	(b)	(b)	22.00		825,561	.76
42	Delaware							146,527	.13
39	District of Columbia						8,000	268,600	.25
40	Florida			(b)	(b)	17.76	70	233,162	.22
15	Georgia	(b)		3,296	53,466	16.22		1,917,960	1.77
38	Idaho and Nevada			(b)	(b)	40.00		339,356	.31
3	Illinois	124,425	(b)	15,984	250,444	15.67	8,928	10,752,160	9.95
6	Indiana	505,908		8,445	115,895	13.72	265,974	5,979,677	5.53
9	Iowa						21,583	4,050,787	3.75
10	Kansas	(b)		(b)	(b)	17.58	19,635	2,248,805	2.08
11	Kentucky	215,000		44,358	770,221	17.36		2,085,460	1.93
30	Louisiana						39,501	623,753	.58
34	Maine			(b)	(b)	15.00		542,730	.50
22	Maryland	(b)	$23,538	9,975	179,469	17.99	9,900	1,165,412	1.08
20	Massachusetts	104,386	169,811	1,716	63,241	36.85		1,397,636	1.29
16	Michigan	(b)					40,100	1,666,381	1.54
18	Minnesota			(b)	(b)	15.00		1,508,710	1.40
28	Mississippi			(b)	(b)	15.15	5,000	806,889	.75
7	Missouri	(b)	(b)	60,544	1,357,387	22.42	56,555	5,562,548	5.15
36	Montana	(b)		868	40,890	47.11		387,525	.36
25	Nebraska			(b)	(b)	25.00	16,518	946,516	.88
37	New Hampshire			(b)	(b)	30.00		371,640	.34
5	New Jersey	835,499	(b)	36,751	800,987	21.79	285,978	6,363,705	5.89
43	New Mexico			(b)	(b)	24.61	212	140,671	.13
4	New York	40,066	102,985	12,289	436,847	35.55	35,800	7,270,981	6.73
26	North Carolina			700	7,560	10.80		930,606	.86
41	North Dakota			(b)	(b)	25.57		206,222	.19
1	Ohio	1,438,042	(b)	84,427	1,339,810	15.87	444,901	15,915,703	14.73
32	Oklahoma			(b)	(b)	40.00	16,000	562,929	.52
33	Oregon			252	6,566	26.06		555,768	.51
2	Pennsylvania	337,948	129,686	222,362	4,252,325	19.12	571,832	13,566,479	12.55
31	South Carolina			2,128	30,257	14.22		606,779	.56
46	South Dakota							63,847	.06
23	Tennessee			1,821	21,029	11.55		1,123,802	1.04
13	Texas	(b)		3,796	69,039	18.19	10,142	1,941,589	1.80
29	Utah			1,168	35,595	30.48	6,245	655,067	.61
45	Vermont		(b)					89,064	.08
19	Virginia			(b)	(b)	15.39	3,450	1,499,130	1.39
12	Washington			1,407	42,045	29.88	3,991	2,083,688	1.93
21	West Virginia	49,220		2,602	38,943	14.97		1,177,915	1.09
24	Wisconsin	(b)						949,095	.88
47	Wyoming							52,282	.05
	Other States [c]	142,802	103,956	7,573	129,925	17.16		(d)	
		[e]3,877,780	529,976	552,366	10,696,216	19.36	2,268,517	108,062,207	100.00
	Per cent of brick and tile products	3.59	.49		9.90		2.10	100.00	
	Per cent of total of clay products	2.91	.40		8.03		1.70	81.13	

[a] Including adobes, assayer's supplies, brick for chemical purposes, burnt clay ballast, charcoal furnaces, chimney pipe, flues and tops, conduits, crucibles, curbing, flue lining, gas logs, glass house supplies, muffles, radial chimney brick, retorts, scorifiers, sewer brick, sleeves and nozzles, stone pumps, vases and ornaments, and wall coping.

[b] Included in "Other States."

[c] Includes all products made by less than three producers in one State.

[d] The total of "Other States" is distributed among the States to which it belongs in order that they may be fully represented in the totals.

[e] Includes roofing tile, valued at $806,609 (estimated), made in the following States: California, Georgia, Illinois, Indiana, Kansas, Kentucky, Maryland, Michigan, Missouri, New Jersey, New York, Ohio, and West Virginia.

Brick and tile products in the United States in 1909.

Rank.	State.	Common brick. Quantity.	Common brick. Value.	Average price per thousand.	Vitrified brick or block. Quantity.	Vitrified brick or block. Value.	Average price per thousand.
		Thousands.			*Thousands.*		
19	Alabama	146,180	$799,693	$5.47	20,444	$262,376	$12.83
44	Arizona	10,702	97,555	9.12	....	....	....
34	Arkansas	69,726	452,505	6.49	(a)	(a)	9.41
9	California	276,396	1,749,209	6.33	7,180	135,203	18.83
15	Colorado	121,908	801,833	6.58	(a)	(a)	14.12
22	Connecticut and Rhode Island	242,000	1,408,033	5.82	(a)	(a)	13.00
41	Delaware	23,301	198,888	8.54	....	....	....
42	District of Columbia	27,937	180,319	6.45	....	....	....
39	Florida	46,272	289,016	6.25	....	....	....
14	Georgia	275,809	1,469,839	5.33	(a)	(a)	12.00
38	Idaho and Nevada	45,703	368,686	8.07	(a)	(a)	25.00
3	Illinois	1,257,025	5,927,054	4.72	140,105	1,562,373	11.15
7	Indiana	251,227	1,579,185	6.29	53,597	559,201	10.44
8	Iowa	153,065	1,072,340	7.01	18,586	198,780	10.70
12	Kansas	254,890	1,160,877	4.55	103,264	932,419	9.03
13	Kentucky	119,183	741,115	6.22	(a)	(a)	12.69
36	Louisiana	78,190	460,988	5.90	....	....	....
33	Maine	54,981	375,168	6.82	(a)	(a)	14.42
23	Maryland	148,673	914,420	6.15	(a)	(a)	13.10
20	Massachusetts	183,584	1,177,281	6.41	....	....	....
16	Michigan	219,820	1,250,787	5.69	10,473	129,283	12.34
18	Minnesota	161,585	969,729	6.00	(a)	(a)	9.00
31	Mississippi	112,402	691,000	6.15	....	....	....
6	Missouri	276,403	1,961,805	7.10	59,863	781,706	13.06
37	Montana	29,818	258,510	8.67	(a)	(a)	20.00
26	Nebraska	139,151	946,532	6.80	(a)	(a)	10.50
35	New Hampshire	75,049	532,965	7.10	....	....	....
5	New Jersey	460,966	2,609,605	5.66	(a)	(a)	11.41
43	New Mexico	11,244	94,395	8.40	(a)	(a)	13.01
4	New York	1,542,552	7,760,746	5.03	16,063	238,697	14.86
24	North Carolina	188,313	1,140,727	6.06	....	....	....
40	North Dakota	20,944	160,540	7.65	....	....	....
2	Ohio	420,999	2,429,879	5.77	324,530	3,113,128	9.59
28	Oklahoma	156,889	952,453	6.07	7,186	58,388	8.13
30	Oregon	64,569	529,110	8.19	....	....	....
1	Pennsylvania	872,658	5,607,490	6.43	116,735	1,329,317	11.39
48	Porto Rico	4,199	34,326	8.17	....	....	....
32	South Carolina	121,063	716,379	5.91	....	....	....
46	South Dakota	5,753	57,460	9.99	....	....	....
21	Tennessee	159,328	1,022,282	6.42	(a)	(a)	13.08
11	Texas	293,660	1,890,601	6.44	(a)	(a)	10.32
29	Utah	56,786	381,186	6.71	....	....	....
45	Vermont	10,395	63,724	6.13	....	....	....
17	Virginia	249,794	1,540,648	6.17	....	....	....
10	Washington	143,198	1,081,579	7.55	(a)	(a)	18.72
25	West Virginia	53,983	327,141	6.06	45,661	565,218	12.38
27	Wisconsin	147,741	956,232	6.47	....	....	....
47	Wyoming	5,856	59,280	10.12	....	....	....
......	Other States [b]	....	....	....	99,967	1,403,497	14.04
	Total	9,791,870	57,251,115	5.85	1,023,654	11,269,586	11.01
	Per cent of brick and tile products	....	42.32	....	....	8.33	....
	Per cent of total of clay products	....	34.42	....	....	6.78	....

[a] Included in "Other States."
[b] Includes all products made by less than three producers in one State.

Brick and tile products in the United States in 1909—Continued.

Rank.	State.	Front brick. Quantity.	Front brick. Value.	Average price per thousand.	Fancy or ornamental brick (value).	Drain-tile (value).	Sewer pipe (value).	Architectural terra cotta (value).	Fire-proofing (value).
		Thousands.							
19	Alabama	(a)	(a)	$16.19	(a)	(a)	(a)	....	(a)
44	Arizona	(a)	(a)	30.00	....	(a)	....	....	....
34	Arkansas	(a)	(a)	12.84	....	$5,300	....	....	....
9	California	10,359	$309,770	29.90	(a)	29,620	$904,473	$345,402	$128,447
15	Colorado	38,782	473,039	12.20	....	13,626	(a)	....	(a)
22	Connecticut and Rhode Island	(a)	(a)	14.00	(a)	....	....	....	....
41	Delaware	(a)	(a)	17.58	....	(a)	....	....	....
42	District of Columbia	(a)	(a)	12.00	....	(a)	(a)	....	(a)
39	Florida	....	....	....	....	(a)	....	....	(a)
14	Georgia	7,188	61,131	8.50	(a)	4,820	351,492	(a)	(a)
38	Idaho and Nevada	2,073	45,009	21.71	....	....	....	....	....
3	Illinois	32,416	385,170	11.88	$12,223	1,613,593	394,461	1,898,865	439,796
7	Indiana	50,135	511,171	10.20	(a)	2,018,401	332,449	(a)	410,500
8	Iowa	12,015	138,218	11.50	(a)	2,830,910	282,637	....	304,398
12	Kansas	26,170	235,875	9.01	(a)	37,862	(a)	(a)	(a)
13	Kentucky	11,626	104,022	8.95	(a)	53,213	(a)	(a)	(a)
36	Louisiana	(a)	(a)	10.15	....	(a)	....	....	....
33	Maine	(a)	(a)	11.20	....	(a)	(a)	....	....
23	Maryland	1,350	20,582	15.25	(a)	5,695	....	(a)	....
20	Massachusetts	1,790	45,050	25.17	(a)	....	....	(a)	(a)
16	Michigan	2,379	18,654	7.84	....	364,006	(a)	....	(a)
18	Minnesota	14,350	171,600	11.96	....	109,371	(a)	....	53,398
31	Mississippi	1,871	22,554	12.05	....	62,605	....	....	....
6	Missouri	36,194	589,782	16.30	29,683	127,166	1,162,730	(a)	110,464
37	Montana	(a)	(a)	17.55	....	....	(a)	....	(a)
26	Nebraska	(a)	(a)	18.17	....	(a)	....	....	(a)
35	New Hampshire	....	....	....	....	....	....	....	....
5	New Jersey	80,855	862,245	10.66	8,578	37,211	(a)	1,637,705	1,299,540
43	New Mexico	3,491	46,973	13.46	(a)	....	....	(a)	....
4	New York	9,815	148,126	15.09	....	125,640	126,908	998,535	199,999
24	North Carolina	725	9,250	12.76	....	8,890	(a)	....	....
40	North Dakota	5,805	103,762	17.87	....	....	....	....	....
2	Ohio	130,684	1,393,787	10.67	24,367	2,032,528	3,009,798	(a)	804,637
28	Oklahoma	1,796	21,473	11.96	....	....	....	....	....
30	Oregon	6,436	119,085	18.50	....	43,198	(a)	....	(a)
1	Pennsylvania	194,695	2,111,556	10.85	27,963	14,668	445,594	428,522	324,860
48	Porto Rico	....	....	....	....	(a)	....	....	....
32	South Carolina	(a)	(a)	15.00	....	....	....	....	....
46	South Dakota	(a)	(a)	11.20	....	....	....	....	....
21	Tennessee	11,397	125,661	11.03	(a)	67,472	(a)	....	(a)
11	Texas	26,726	407,023	15.23	(a)	28,414	(a)	....	20,170
29	Utah	31,755	317,189	9.99	....	(a)	(a)	....	....
45	Vermont	....	....	....	....	(a)	....	....	....
17	Virginia	24,717	333,057	13.47	(a)	6,298	(a)	....	....
10	Washington	7,802	155,600	19.94	....	18,495	737,847	206,324	71,067
25	West Virginia	(a)	(a)	14.74	....	(a)	(a)	....	(a)
27	Wisconsin	7,788	74,120	9.52	(a)	95,899	....	....	(a)
47	Wyoming	525	8,475	16.14	....	....	....	....	....
......	Other States[b]	22,454	343,210	15.29	71,259	44,257	2,573,935	736,272	299,432
	Total	816,164	9,712,219	11.90	[c]1,167,975	9,799,158	10,322,324	6,251,625	4,466,708
	Per cent of brick and tile products	....	7.18	......	.87	7.25	7.63	4.62	3.30
	Per cent of total of clay products	....	5.84	......	.70	5.89	6.21	3.76	2.69

[a] Included in "Other States."
[b] Includes all products made by less than three producers in one State.
[c] Includes enameled brick, valued at $993,902, made in the following States: California, Illinois, Maryland, Missouri, New Jersey, and Pennsylvania.

Brick and tile products in the United States in 1909—Continued.

Rank.	State.	Tile, not drain (value).	Stove lining (value).	Fire brick.		Average price per thousand.	Miscellaneous (value).[a]	Total value.	Per cent of total value.
				Quantity.	Value.				
				Thousands.					
19	Alabama			14,119	$196,887	$13.94	$993	$1,663,788	1.23
44	Arizona	(b)					155	107,940	.08
34	Arkansas			(b)	(b)	13.10		600,550	.44
9	California	$130,941	(b)	11,277	297,577	26.39	207,494	4,312,590	3.19
15	Colorado	(b)		12,440	265,089	21.31	89,846	1,994,798	1.47
22	Connecticut and Rhode Island		(b)	(b)	(b)	29.26		1,515,595	1.12
41	Delaware							231,505	.17
42	District of Columbia							214,489	.16
39	Florida			(b)	(b)	18.00	487	298,620	.22
14	Georgia	(b)		3,168	62,452	19.71	34,432	2,265,121	1.67
38	Idaho and Nevada							416,695	.31
3	Illinois	335,020		31,210	682,793	21.88	53,670	13,505,898	9.98
7	Indiana	(b)		14,113	280,921	19.91	412,921	6,744,295	4.99
8	Iowa			(b)	(b)	15.00	18,748	4,846,706	3.58
12	Kansas	(b)		(b)	(b)	15.00	4,424	2,709,822	2.00
13	Kentucky	296,179	(b)	51,645	899,363	17.41	17,966	2,332,475	1.72
36	Louisiana						33,655	528,261	.39
33	Maine			(b)	(b)	16.90	907	635,667	.47
23	Maryland		$25,925	16,037	278,777	17.38	11,430	1,400,380	1.04
20	Massachusetts	69,837	159,530	2,101	75,160	35.77		1,631,858	1.21
16	Michigan	(b)					66,128	1,947,059	1.44
18	Minnesota	(b)						1,755,438	1.30
31	Mississippi			(b)	(b)	15.22	2,500	779,009	.58
6	Missouri	(b)	(b)	78,678	1,598,302	20.31	212,799	7,367,061	5.45
37	Montana			3,147	130,079	41.33		451,389	.33
26	Nebraska						36,982	1,146,449	.85
35	New Hampshire			(b)	(b)	26.74		552,215	.41
5	New Jersey	992,606		35,454	907,276	25.59	462,731	9,380,958	6.93
43	New Mexico			954	23,779	24.93		182,755	.13
4	New York	62,795	79,653	12,674	491,872	38.81	37,256	10,270,227	7.59
24	North Carolina						5,035	1,283,902	.95
40	North Dakota			(b)	(b)	21.55		269,324	.20
2	Ohio	1,912,343	23,803	103,148	1,730,401	16.78	437,814	16,929,885	12.52
28	Oklahoma							1,032,314	.76
30	Oregon			259	8,000	30.89	910	827,963	.61
1	Pennsylvania	441,243	97,270	417,836	8,107,807	19.40	464,934	19,403,944	14.34
48	Porto Rico							34,506	.03
32	South Carolina			1,634	24,083	14.74		751,037	.56
46	South Dakota							68,660	.05
21	Tennessee			(b)	(b)	12.16	2,000	1,575,262	1.16
11	Texas			7,448	123,393	16.57	64,211	3,026,035	2.24
29	Utah		(b)	(b)	(b)	27.28	7,593	874,159	.65
45	Vermont		(b)					83,360	.06
17	Virginia			(b)	(b)	13.43		1,919,771	1.42
10	Washington			2,853	103,531	36.29	4,000	3,044,275	2.25
25	West Virginia	82,461		5,003	80,773	16.14	800	1,159,627	.86
27	Wisconsin			(b)	(b)	14.85	2,000	1,130,380	.84
47	Wyoming							67,755	.05
	Other States[c]	968,538	37,402	12,969	252,380	19.46		(d)	
	Total	5,291,963	423,583	838,167	16,620,695	19.83	2,694,821	135,271,772	100.00
	Per cent of brick and tile products	3.91	.31		12.29		1.99	100.00	
	Per cent of total of clay products	3.18	.25		9.99		1.62	81.33	

[a] Including adobes, aquarium ornaments, burnt clay ballast, charcoal furnaces, chimney pipe, pots and tops, conduits, crucibles, curbing, dental furnaces, fence posts, flue lining, gas logs, glasshouse supplies, muffles, radial chimney brick and blocks, retorts, saggers, scorifiers, sewer brick, stone pumps, vases and ornaments, and wall coping.

[b] Included in "Other States."

[c] Includes all products made by less than three producers in one State.

[d] The total of "Other States" is distributed among the States to which it belongs in order that they may be fully represented in the totals.

Common brick, as its name implies, is the most widely spread of all brick products and in fact of all clay products, being reported from every State and Territory except Alaska. In 1909 Porto Rico appeared for the first time as a producer. There were 9,791,870,000 common brick, valued at $57,251,115, reported in 1909, a gain over 1908 of 1,980,824,000 brick, or 25.36 per cent. In 1908 common brick showed a loss of 1,984,652,000, or 20.26 per cent, from 1907, so that the output of 1909 was within 3,828,000 brick of the production of 1907 and within 235,169,000 of the maximum quantity reported in 1906. The value of the common brick showed an increase in 1909 over 1908 of $12,485,501, or 27.89 per cent, but was $1,534,346 less than that of 1907 and $4,143,268 less than that of the maximum in 1905. Only 6 States showed decrease in quantity of production in 1909, none of which were important brickmaking States; they were Arizona, Mississippi, Montana, New Mexico, South Dakota, and Vermont, and in none of them were the losses great. In 1908 only 6 States showed increase in quantity of common brick reported. Of the 6 States that showed decrease in quantity in 1909, only 3—Arizona, Mississippi, and Montana—showed decrease in value; and one State—Louisiana—that showed an increase in quantity showed a decrease in value. Oklahoma had the largest proportionate increase in value—over 100 per cent—and New York made the largest actual gain—$2,694,662, or over 50 per cent; and New Jersey also showed a large increase—$1,029,770, or over 65 per cent. Illinois, which was the leading common-brick producing State in 1907 and 1908, was second in 1909, being displaced by New York. Of New York's output 1,246,674,000 brick, or 80.82 per cent, was from the Hudson River region, and of the Illinois output, 855,248,000 brick, or 68.04 per cent, was reported from Cook County. The average price per thousand for common brick in 1909 ranged from $4.55 in Kansas to $10.12 in Wyoming, the average for the whole country being $5.85; in 1908 also these States reported the extremes, $3.97 and $10.33. In Illinois, the average price was $4.72, an increase of 40 cents over 1908; in New York, $5.03, an increase of 23 cents; and in Pennsylvania, $6.43, an increase of 10 cents. Common brick constituted 42.32 per cent of the value of the brick and tile production in 1909, and 34.42 per cent of all clay products; in 1908 these percentages were 41.43 and 33.61, respectively.

Vitrified paving brick reported for 1909 numbered 1,023,654,000, valued at $11,269,586, a gain of 45,532,000 brick, or 4.66 per cent, in quantity and of $612,111, or 5.74 per cent, in value. Ohio continues to be the leading State, reporting 324,530,000 brick, valued at $3,113,128, or $9.59 per thousand. This was a decrease of 3,188,000 brick, or 0.97 of 1 per cent in quantity and of $119,207, or 3.69 per cent, in value. Ohio reported 31.70 per cent of the output and 27.62 per cent of the total value of brick in 1909; in 1908 these percentages were 33.50 and 30.33, respectively. Illinois and Pennsylvania were second and third in quantity and value. Vitrified brick was reported from 29 States in 1909 and from 30 in 1908, North Carolina reporting none in 1909. The average price per thousand ranged in the important producing States from $9.03 in Kansas to $14.86 in New York; the average, for the country was $11.01, Illinois being the nearest to the general average, with $11.15. In 1908 the average price for the whole country was $10.90. Vitrified brick composed 8.33 per cent of the value of all brick and tile products and 6.78 per cent of all clay products in 1909; in 1908 these percentages were 9.86 and 8, respectively.

The front brick reported in 1909 numbered 816,164,000, valued at $9,712,219, or $11.90 per thousand, an increase of 231,682,000 brick, or 39.64 per cent in quantity and of $2,776,619, or 40.03 per cent in value. As for several preceding years, Pennsylvania, Ohio, and New Jersey were the leading States in 1909 in the order named; they reported 49.77 per cent of the output and 44.97 per cent of the value of front brick for the entire country for 1909. The average price per thousand ranged from $7.84 in Michigan to $30 in Arizona. In the leading three States the prices were, Pennsylvania, $10.85; Ohio, $10.67; and New Jersey, $10.66. Next to common brick, front brick is the most widely distributed of the clay-working industries; only 4 States and Territories—namely, Florida, New Hampshire, Porto Rico, and Vermont—reported no production in 1909. Front brick constituted 7.18 per cent of the value of all brick and tile products in 1909 and 6.42 per cent in 1908.

The use of drain tile continues to grow. It has steadily increased in value for several years, and was reported to the value of $9,799,158 for 1909, as compared with $8,661,476 in 1908 (when the industry flourished in spite of the general depression), a gain of $1,137,682, or 13.13 per cent. Iowa, Ohio, Indiana, and Illinois are the leading States, in the order named. These four great agricultural States, together with Michigan, reported drain tile, valued at $8,859,438, or 90.41 per cent of the total for the country; in 1908 these States reported drain tile valued at $7,781,804, or 89.84 per cent of the total. Of these leading States, Iowa showed a gain in 1909 over 1908 of $321,405; Ohio, of $307,066; Indiana, of $221,072; Illinois, of $191,715; and Michigan, of $36,376. Drain tile constituted 7.25 per cent of the value of all brick and tile products in 1909 and 8.01 per cent in 1908.

Sewer pipe was the only important clay product having a decrease in value in 1909. Correspondence with the leading producers showed that this apparent loss was due to the fact that the figures called for on the census schedules were manufactured output instead of marketed output, which has been the basis of the figures collected by the Survey. In this particular industry, therefore, a comparison between 1908 and 1909 is of no value.

The demand for architectural terra cotta is usually limited to the largest and best buildings. Furthermore, it is a product that will justify transportation. Hence the production is confined to a few States where the skilled labor required in its manufacture is available. This product in 1909 was reported from 15 States, in only 6 of which were there enough producers to permit the publication of figures without revealing individual operations. Illinois was the leading State, closely followed by New Jersey. In 1909 architectural terra cotta composed 4.62 per cent of the value of brick and tile products and 3.76 per cent of the value of all clay products; in 1908 these percentages were 4.24 and 3.44, respectively.

Fireproofing and hollow building tile or block, owing to their similarity, have not been separated in the collection of data. The use of these materials both for partitions and for outer walls has increased considerably, and they showed a gain in value in 1909 of $1,298,671, or 40.99 per cent. New Jersey continued to be the leading State, reporting 29.09 per cent of the entire output; Ohio was second, reporting 18.01 per cent of the output. These materials were reported from 27 States in 1909 and 28 in 1908. They constituted 3.30 per cent of the value of the brick and tile products and 2.69 per cent of all clay products in 1909; in 1908 these percentages were 2.93 and 2.38, respectively.

The wares included under "Tile, not drain," are roofing, floor, wall, and art tile. In 1909 these high-grade wares were reported from 17 States, but so few are the plants that it is not possible to give figures for more than 9 States without revealing individual returns. Ohio has been the leading State in the production of these wares for many years; the output of that State was valued at $1,912,343, a gain for 1909 over 1908 of $474,301, or 32.98 per cent. New Jersey was second. These two States reported 54.89 per cent of the output for the entire country. Pennsylvania is also a large producer of these wares. They constituted 3.91 per cent of the value of all brick and tile products in 1909 and 3.18 per cent of all clay products.

Stove lining showed a decrease in production in 1909, as in 1908. Massachusetts continued to be the leading State, and Pennsylvania was second. Each State showed a decrease; that in Pennsylvania was large—$32,416, or 25 per cent.

The fire-brick industry in 1909 was second only to common brick in value of product. Fire brick was reported from 34 States in 1909 and from 37 in 1908. Iowa and Wisconsin entered the list of producers, and Idaho and Nevada, Minnesota, Nebraska, North Carolina, and Oklahoma dropped out. The figures given in this report for quantity represent the product reduced to the equivalent of a 9-inch fire brick. The quantity so reported for 1909 was 838,167,000, a gain of 285,801,000 brick, or 51.74 per cent. The output in 1909 was 55,150,000 brick, or 7.04 per cent greater than that of 1907. In 1908 fire brick fell off 29.46 per cent. The value showed even a larger increase in 1909 over 1908—$5,924,479, or 55.39 per cent—than the quantity. Part of this great increase was due to the inclusion for the first time of silica brick with clay fire brick, though, no doubt, there was a large increase in the clay fire-brick product to keep pace with the increase in output of pig iron. The average value per thousand increased from $19.36 in 1908 to $19.83 in 1909. Pennsylvania continued to be the largest producer, reporting 417,836,000 fire brick, or nearly 50 (49.85) per cent of the whole output, and $8,107,807, or 48.78 per cent, of the value. Ohio was second in both quantity and value, and Missouri was third. Kentucky was fourth in quantity and fifth in value, and New Jersey fifth in quantity and fourth in value. These relative ranks were also maintained in 1908. Illinois was sixth in quantity and value; New York tenth in quantity and seventh in value; Maryland was seventh in quantity and tenth in value. California was twelfth in quantity and eighth in value; Indiana ninth in both The other States are comparatively small producers. The average value per thousand is variable, depending probably more on quality than any other clay product. The price per thousand ranged in 1909 from $12.16 in Tennessee to $41.33 in Montana. The average price of Indiana's product was nearest to the general average. Fire brick composed 12.29 per cent of the value of all brick and tile products and 9.99 per cent of that of all clay products in 1909; in 1908 these percentages were 9.90 and 8.03, respectively.

Pennsylvania was again the leading State in the value of brick and tile products, regaining that position which was wrested from her by Ohio in 1908. The value of Pennsylvania's brick and tile output increased $5,837,465, or 43.03 per cent, in 1909, exceeding that of 1907 by $422,201. Ohio, which was second in value for many years but was first in 1908, fell back to second place in 1909, reporting 12.52 per cent of the total and a state increase of $1,014,182, or 6.37 per cent. Illinois continued in third place, reporting 9.98 per cent of the value for the entire country and a state increase of $2,753,738, or 25.61 per cent. New York was fourth in both 1908 and 1909, and New Jersey fifth in both years. New York's output increased $2,999,246, or 41.25 per cent, and New Jersey's $3,017,253, or 47.41 per cent. Missouri, which was seventh in 1908, was sixth in 1909, displacing Indiana; and Iowa, which was ninth in 1908, was eighth in 1909, exchanging places with California. Similarly Kansas, which was tenth in 1908, and Washington, which was twelfth, exchanged places in 1909, Texas becoming eleventh.

HUDSON RIVER REGION.

Of the three great common-brick producing regions—Hudson River, Philadelphia, and Chicago—the oldest and largest producer is the Hudson River region, which comprises 10 counties along Hudson River from New York City to Cohoes, and embraces both sides of the river. Nine of these counties are located in New York and one—Bergen—in New Jersey. The market for the brick of this region is Greater New York and vicinity, which is favorably located as regards transportation, the product being brought by water. Until a few years ago these brick were taken to market by schooners. But here, as elsewhere, the picturesque sail has been displaced by steam, and they are now towed on scows by steam tugs, one tow frequently carrying several hundred thousand brick.

In this connection a statement of the history of brickmaking in Rockland County may be of interest. The writer is indebted to The History of Rockland County (New York), by Frank Bertangue Green, M. D., published in 1886, for the following information:

Prior to the Revolution attempts to manufacture brick were made, but the few brick produced were only for local use. At Upper Nyack a yard existed before the close of the eighteenth century, but so little did it impress the minds of the people that all data respecting it are lost.

A brick made in Haverstraw and marked 1792 was in existence at the time Doctor Green was preparing his history.

The industry may, however, be considered as having been fairly started in 1810 when the first kiln was burned for a regular market, under the management of a company from Philadelphia. This enterprise failed, and the work was abandoned. In 1817, James Wood, a native of England, who had learned his trade in his native land, was attracted to Haverstraw by the vast quantity of brick clay and the unlimited supply of wood, and leased a piece of land on the river shore and started the first successful brickyard in the county.

When Wood opened his yard in Haverstraw the process of making brick was the same as that pursued from the earliest times. To

Wood is given the credit of discovering in 1828 the use of coal dust as an ingredient in the manufacture of brick. It seems true that this process had been used in England, but so little was it known that a long and bitter litigation ensued to test the validity of Wood's patent. An English friend sent him a small quantity of anthracite coal, which was then being developed in Pennsylvania. On burning it he found that it gave an intense heat with little smoke. The idea came to him that coal could be used to burn brick. A piece of coal was pulverized and mixed with the clay for four bricks. The burning of these bricks showed that the experiment was a success. It remained, however, to learn the proper proportion of clay and coal dust. Wood obtained a load of anthracite coal and had it ground in a neighboring grist mill. He mixed this coal with the clay in nearly equal proportions, but the kiln burned to slag and was ruined. Further tests were made and at last the proper proportions were ascertained. It was found that bricks with coal dust in them burned in the upper layers of the kiln as well as in the lower layers and that a uniform burn throughout the kiln could be obtained by this process.

Wood is also said to have invented a machine consisting of a wooden axle with spokes projecting from it, which, revolving on a central shaft, mixed the clay, sand, and coal dust more rapidly than had been done before. This machine was probably the forerunner of the ring-pit tempering wheel of to-day. Another improvement which Wood was the means of introducing was a mold with a bottom and a vent. To that time molds without bottoms had been used. These molds, when filled, required great care in handling. The time saved by Wood's discoveries and improvements was from seven to ten days to a kiln.

The next yard established after Wood's was by the Allison family, north of the foot of the present main street in Haverstraw, and in a short time several yards were opened at Grassy Point and below Caldwell's Landing. By 1834 these yards were in a precarious financial condition. In November of that year, however, David Munn took hold of the brick business with a determination to make it pay, and succeeded. In 1838 there were six yards in operation with an annual production of 12,000,000 brick. In the following years the industry advanced rapidly, largely through the efforts of David Munn. In 1852 a fresh impetus was given to the brick industry by the invention of an automatic brick machine by Richard A. Ver Valen. Hall's improved machine had been in use for some time, but was operated by hand, and, besides, the brick were so soft as to require great care in handling. Ver Valen's machine not only tempered the clay, but molded the brick so stiff that they retained their shape perfectly. This machine was the cause of litigation that was decided in Ver Valen's favor.

The first recorded brickmaker's strike in this region was in 1853, when hundreds of strikers marched from yard to yard uttering threats of violence. The strike was so severe that troops had to be called out to suppress it. In 1877 another strike occurred. At this time the operators sent to Canada for laborers. When the French Canadians thus engaged began work violence was resorted to by the strikers and the troops were called out again.

The total number of brick marketed from this region in 1909 was 1,313,760,000, against 875,979,000 in 1908. This was a gain of

437,781,000 brick, or 49.98 per cent. In 1908 there was a decrease of 188,913,000 brick, or 17.74 per cent. The product of 1909 was 248,868,000 brick greater than that of 1907 and 16,371,000 brick greater than the maximum output of 1905. The total value increased from $4,107,382 in 1908 to $6,438,642 in 1909, a gain of $2,331,260, or 56.76 per cent. This value is $2,625,111 less than that of 1905, because of the much higher price, $6.99 per thousand, obtained in 1905. The average price per thousand in 1909 was $4.90, compared with $4.69 in 1908.

New York's portion was 94.89 per cent of the output and 94.12 per cent of the value of the region. This portion, consisting of 1,246,674,000 brick, was an increase of 426,113,000 brick, or 51.93 per cent, and constituted 80.82 per cent of New York's output of common brick, and was greater than the output of common brick in any other State except Illinois. The value of New York's portion of the product of this region was $6,060,031, an increase of $2,232,517, or 58.33 per cent. This value was greater than that of common brick in any other State, and was exceeded by the total value of the clay products in only seven other States. The value of the common brick of New York's portion of this region was 49.85 per cent of all of New York's clay products, and 59.01 per cent of its brick and tile products.

Of the counties included in this region Ulster was the first in output in 1909, reporting 304,737,000 brick, and Rockland was second with 289,479,000 brick. In value they were reversed, Rockland's output being valued at $1,499,678 and Ulster's at $1,466,194. In 1908 Ulster was first in both quantity and value. In Rensselaer the highest average prices per thousand were obtained, $5.36 in 1909 and $5.55 in 1908. The lowest average price in 1909 was in Columbia County, $4.31. Rockland County had the largest number of plants, 30, an increase of 1 over 1908.

The average price per thousand of the whole region in 1909 was $4.90 as compared with $4.69 in 1908 and with $5.18 in 1907; in 1906 it was $6.02, and in 1905, $6.99. The average price per thousand in this region has ranged from $4.42 in 1902 to $6.99 in 1905.

New Jersey's portion of this region is small, being in 1909 only 5.11 per cent of the output and 5.88 per cent of the value. This was an increase of 11,668,000 brick, or 21.05 per cent, in quantity, and of $98,743, or 35.28 per cent, in value. The average price per thousand increased from $5.05 in 1908 to $5.64 in 1909. The number of firms in New Jersey reporting decreased from 11 in 1908 to 10 in 1909. The average price in 1909 in New Jersey was 78 cents per thousand higher than in New York's portion of the region, and 28 cents per thousand higher than that of Rensselaer County, the highest average price received in any county in this region in New York.

The number of firms in the region reporting increased from 123 in 1908 to 127 in 1909; there was an increase of 5 in New York and a decrease of 1 in New Jersey, making the net gain of 4.

Production of common brick in the Hudson River district from Cohoes to New York City in 1908 and 1909, by counties.

County.	1908.				1909.			
	Number of firms reporting.	Quantity.	Value.	Average price per thousand.	Number of firms reporting.	Quantity.	Value.	Average price per thousand.
		Thousands.				*Thousands.*		
Albany	12	55,677	$255,013	$4.58	11	79,250	$385,787	$4.87
Columbia	4	61,971	283,720	4.58	4	90,644	390,885	4.31
Dutchess	18	132,005	606,372	4.59	19	171,898	779,080	4.53
Greene	4	12,095	57,723	4.77	5	42,257	204,101	4.83
Orange	8	151,869	746,637	4.92	9	167,307	799,172	4.78
Rensselaer	6	10,949	60,724	5.55	7	22,126	118,567	5.36
Rockland	29	174,026	800,603	4.60	30	289,479	1,499,678	5.18
Ulster	24	182,167	831,948	4.57	24	304,737	1,466,194	4.81
Westchester	7	39,802	184,774	4.64	8	78,976	416,567	5.27
Total for New York	112	820,561	3,827,514	4.66	117	1,246,674	6,060,031	4.86
Bergen County, N. J	11	55,418	279,868	5.05	10	67,086	378,611	5.64
Total	123	875,979	4,107,382	4.69	127	1,313,760	6,438,642	4.90

POTTERY.

INTRODUCTION.

The following tables show the status of the pottery industry in 1909 and 1908. As with the brick and tile industry, these figures were collected in cooperation with the Bureau of the Census. Since the basis of collection of the 1909 figures was that of production instead of marketed product, in order to make the statistics of labor and wages of value in the census investigation, the statistics are not strictly comparable with those of 1908.

The figures show that the industry was in a prosperous condition and has practically recovered from the depression of 1907-8. The value of the product showed a large gain over 1908, $5,913,886, or 23.53 per cent. The product in 1909 was valued at $905,967 more than that of 1907, and was only 1.25 per cent less than the largest pottery product ever reported, that for 1906.

The outlook for domestic pottery seems most promising. With the constantly improving product and increasingly attractive ware produced, with the proportion of domestic products to consumption the largest ever known, with production showing an increase of nearly one-fourth and imports an increase of less than 1 per cent, 1909 was a noteworthy year in the history of the American pottery industry.

PRODUCTION.

The following table shows the statistics of the pottery production of the United States from 1905 to 1909:

Value of pottery products in the United States, 1905–1909, by varieties.

Year.	Number of operating firms reporting.	Red earthenware.	Stoneware and yellow and Rockingham ware.	White ware, including C. C. ware, etc.	China, bone china, delft, and belleek ware.	Sanitary ware.	Porcelain electrical supplies.	Miscellaneous.	Total.
1905......	533	$780,637	$3,969,016	$12,809,414	$1,558,730	$4,580,145	$2,253,061	$1,967,891	$27,918,894
1906......	540	909,262	4,193,884	14,152,503	1,787,776	5,098,310	2,838,284	2,460,865	31,440,884
1907......	509	845,465	4,280,601	13,913,680	1,930,669	4,863,222	2,613,771	1,696,066	30,143,474
1908......	497	757,900	3,518,841	11,474,147	1,581,020	4,373,590	2,009,005	1,421,052	25,135,555
1909......	466	805,906	3,993,859	13,728,316	[a]1,766,766	5,989,295	3,047,499	[a]1,717,800	31,049,441

[a] China, bone china, delft and belleek ware for Ohio is included in miscellaneous.

This table shows that the value of the pottery products of the United States in 1909 was $31,049,441, an increase over 1908 of $5,913,886, or 23.53 per cent, and that it was within $391,443 of the maximum value reported for 1906. Every product showed an increase in 1909, sanitary ware and porcelain electrical supplies reaching the maximum. The product showing the largest increase was white ware, which gained $2,254,169, or 19.65 per cent, and the largest proportional gain was shown by porcelain electrical supplies, 51.69 per cent, or $1,038,494.

The value of the white ware, exclusive of sanitary ware and porcelain electrical supplies, was $15,495,082, a gain of $2,439,915, or 18.69 per cent, as compared with $13,055,167 in 1908. In 1908 there was a loss in the value of these products of $2,789,182, or 17.60 per cent; in 1907 there was a loss of $95,930; and these products were valued in 1909 at $445,197 less than in 1906, when the maximum was attained. These wares constituted 51.94 per cent of the value of all pottery products in 1908 and 49.90 per cent in 1909. If sanitary ware and porcelain electrical ware be added to the value for 1909 the value would be $24,531,876 or 79.01 per cent of all pottery products; this would be a gain of $5,094,114 over 1908 and of $1,210,534 over 1907. These products composed 77.33 per cent of all pottery in 1908.

In the following tables will be found statistics of the production of pottery in the United States in 1908 and 1909, by States and varieties of product, the former year being given for comparative purposes.

Value of pottery products in 1908, by varieties of products, by States.

Rank of State.	State.	Number of active firms reporting.	Red earthenware.	Stoneware and yellow and Rockingham ware.	White ware, including C. C. ware, white granite, semiporcelain ware, and semivitreous porcelain ware.	China, bone china, delft, and belleek ware.
19	Alabama	21	$15,058	$9,031		
18	Arkansas	5		24,500		
13	California	12	42,962	29,300		
17	Colorado	4	11,250	(a)		
14	Connecticut	4	12,000	(a)		
	District of Columbia		(a)			
24	Georgia	15	5,710	4,941		
6	Illinois	22	24,821	733,373	(a)	
7	Indiana	16	7,450	37,020	(a)	
22	Iowa	7	8,161	7,549		
	Kansas			(a)		
10	Kentucky	12	23,448	130,200		
27	Louisiana	3	(a)			
	Maine			(a)		
8	Maryland	9	9,267	(a)	(a)	
9	Massachusetts	15	150,148	15,409	(a)	
16	Michigan	6	54,659			
	Minnesota		(a)	(a)		
20	Mississippi	7	570	21,180		
15	Missouri	12	3,719	62,689		
	Montana		(a)			
	New Hampshire					
2	New Jersey	56	20,100	(a)	$1,137,701	$876,259
	New Mexico					
4	New York	25	31,645	44,713	(a)	622,548
23	North Carolina	31	775	12,587		
1	Ohio	118	138,431	1,468,197	7,228,636	(a)
	Oregon		(a)	(a)		
5	Pennsylvania	35	138,181	259,095	623,544	69,994
26	South Carolina	5	5,343	3,126		
12	Tennessee	9	(a)	56,532		
11	Texas	14	10,267	114,879		
28	Utah	3	3,450			
	Virginia					
21	Washington	4	2,450	(a)		
3	West Virginia	11		(a)	1,612,321	
25	Wisconsin	3	9,300			
	Other States [b]		28,735	484,520	871,945	12,219
	Total	[c] 497	757,900	3,518,841	11,474,147	1,581,020
	Per cent of pottery products		3.02	14.00	45.65	6.29
	Per cent of total clay products		.57	2.64	8.61	1.19
	Number of firms reporting each variety		179	209	65	16

[a] Included in "Other States."
[b] Includes all products made by less than three producers in one State.
[c] Includes 13 firms not distributed.

Value of pottery products in 1908, by varieties of products, by States—Continued.

Rank of State.	State.	Sanitary ware.	Porcelain electrical supplies.	Miscellaneous.[a]	Total.	Percentage of total.
19	Alabama				$24,089	0.10
18	Arkansas			$3,000	27,500	.11
13	California	(b)		(b)	87,126	.35
17	Colorado			(b)	49,407	.20
14	Connecticut		(b)	11,500	76,000	.30
	District of Columbia				(c)	
24	Georgia				10,651	.04
6	Illinois			45,376	806,954	3.21
7	Indiana	$350,000	(b)	20	760,490	3.03
22	Iowa			3,000	18,710	.07
	Kansas				(c)	
10	Kentucky				153,648	.61
27	Louisiana			5,741	6,171	.02
	Maine				(c)	
8	Maryland			3,000	275,687	1.10
9	Massachusetts		(b)	24,008	249,726	.99
16	Michigan			7,750	62,409	.25
	Minnesota				(c)	
20	Mississippi			100	21,850	.09
15	Missouri			2,500	68,908	.27
	Montana	(b)			(c)	
	New Hampshire			(b)	(c)	
2	New Jersey	3,182,772	$559,556	123,262	5,949,991	23.67
	New Mexico			(b)	(c)	
4	New York	(b)	560,754	94,229	1,658,243	6.60
23	North Carolina				13,362	.05
1	Ohio	233,000	719,034	907,270	10,706,787	42.60
	Oregon			(b)	(c)	
5	Pennsylvania	175,384		10,305	1,276,503	5.08
26	South Carolina				8,469	.03
12	Tennessee			(b)	112,632	.45
11	Texas				125,146	.50
28	Utah				3,450	.01
	Virginia		(b)	(b)	(c)	
21	Washington				20,601	.08
3	West Virginia	385,000	(b)	71,000	2,083,821	8.29
25	Wisconsin				9,300	.04
	Other States[d]	47,434	169,661	108,991	[e]467,924	1.86
	Total	4,373,590	2,009,005	1,421,052	25,135,555	100.00
	Per cent of pottery products	17.40	7.99	5.65	100.00	
	Per cent of total clay products	3.28	1.51	1.07	18.87	
	Number of firms reporting each variety.	36	31	76		

[a] Including art and chemical pottery, ceramic sculpture, craquelle porcelain, faïence, garden vases, Grueby, Hampshire, Indian, Pewabic, and Teco pottery, handmade tile, hanging baskets, incandescent mantle supplies, insulating materials, jardinieres and pedestals, majolica, pins, stilts, and spurs for potters' use; porcelain door knobs, filter tubes, shuttle eyes, and thread guides, porcelain hardware trimmings, tobacco pipes, toy marbles, turpentine cups, and umbrella stands.

[b] Included in "Other States."

[c] Included in ([e]) ($467,924).

[d] Includes all products made by less than three producers in one State.

[e] Made up of State totals of District of Columbia, Kansas, Maine, Minnesota, Montana, New Hampshire, New Mexico, Oregon, and Virginia. The total for "Other States" is distributed among the States to which it belongs.

Value of pottery products in 1909 by varieties of products, by States.

Rank of State.	State.	Number of active firms reporting.	Red earthenware.	Stoneware and yellow and Rockingham ware.	White ware, including C. C. ware, white granite, semiporcelain ware, and semivitreous porcelain ware.	China, bone china delft, and belleek ware.
19	Alabama	19	$11,886	$24,453		
21	Arkansas	4		25,974		
11	California	12	42,464	59,907		
16	Colorado	4	(a)	(a)		
	Connecticut		(a)	(a)		
	District of Columbia		(a)			
20	Georgia	23	12,945	16,435		
7	Illinois	22	31,771	702,411	(a)	
6	Indiana	14	10,090	59,598	(a)	
17	Iowa	6	8,175	(a)		
	Kansas			(a)		
10	Kentucky	10	20,225	126,172		
	Louisiana					
	Maine			(a)		
8	Maryland	8	8,034	(a)	(a)	
9	Massachusetts	13	154,887	14,380	(a)	
13	Michigan	5	60,939			
	Minnesota		(a)	(a)		
22	Mississippi	5		19,341		
15	Missouri	10	4,792	66,830		
	Montana		(a)			
	New Hampshire					
2	New Jersey	58	36,573	66,293	$1,242,361	$1,082,398
	New Mexico					
4	New York	22	30,200	46,905	(a)	592,611
23	North Carolina	24	1,780	16,929		
1	Ohio	113	145,137	1,806,798	8,884,189	(b)
	Oregon		(a)	(a)		
5	Pennsylvania	33	159,796	297,029	812,338	91,757
	Porto Rico		(a)			
26	South Carolina	3	(a)	1,148		
14	Tennessee	5	(a)	35,100		
12	Texas	14	10,889	111,539		
	Utah		(a)			
18	Virginia	3				
24	Washington	3	(a)	(a)		
3	West Virginia	10		(a)	1,769,808	
25	Wisconsin	4	9,109	(a)		
	Other States c		46,214	496,617	1,019,620	
	Total	d466	805,906	3,993,859	13,728,316	b1,766,766
	Per cent of pottery products		2.60	12.86	44.21	5.69
	Per cent of total clay products		.49	2.40	8.26	1.06
	Number of firms reporting each variety		147	196	62	14

a Included in "Other States."
b China, bone china, delft, and belleek ware for Ohio is included in Ohio, "Miscellaneous."
c Includes all products made by less than three producers in one State.
d Includes 19 firms not distributed.

Value of pottery products in 1909 by varieties of products, by States—Continued.

Rank of State.	State.	Sanitary ware.	Porcelain electrical supplies.	Miscellaneous.[a]	Total.	Percentage of total.
19	Alabama				$36,339	0.12
21	Arkansas			$500	26,474	.09
11	California	(b)		9,326	124,575	.40
16	Colorado			16,236	54,226	.18
	Connecticut		(b)	(b)	(c)	
	District of Columbia				(c)	
20	Georgia				29,380	.09
7	Illinois	(b)		25,233	838,555	2.70
6	Indiana	(b)	(b)		900,928	2.90
17	Iowa			2,100	51,990	.17
	Kansas				(c)	
10	Kentucky				146,397	.47
	Louisiana			(b)	(c)	
	Maine				(c)	
8	Maryland	(b)		9,000	320,432	1.03
9	Massachusetts		(b)	21,076	256,028	.82
13	Michigan			34,500	95,439	.31
	Minnesota				(c)	
22	Mississippi				19,341	.06
15	Missouri			1,500	73,122	.24
	Montana				(c)	
	New Hampshire			(b)	(c)	
2	New Jersey	$4,341,040	$823,056	199,415	7,791,136	25.09
	New Mexico			(b)	(c)	
4	New York	(b)	752,185	76,956	1,887,209	6.08
23	North Carolina				18,709	.06
1	Ohio	310,254	1,146,694	[d]1,123,284	13,416,356	43.21
	Oregon			(b)	(c)	
5	Pennsylvania	252,951	(b)	10,464	1,782,769	5.74
	Porto Rico				(c)	
26	South Carolina				1,967	.01
14	Tennessee			(b)	73,610	.24
12	Texas				122,428	.39
	Utah				(c)	
18	Virginia		(b)	(b)	36,746	.12
24	Washington				16,211	.05
3	West Virginia	500,432		71,642	2,350,470	7.57
25	Wisconsin				9,209	.03
	Other States [d]	584,618	325,564	116,568	[e]569,395	1.83
	Total	5,989,295	3,047,499	1,717,800	31,049,441	100.00
	Per cent of pottery products	19.29	9.82	5.53	100.00	
	Per cent of total clay products	3.60	1.83	1.03	18.67	
	Number of firms reporting each variety.	35	40	79		

[a] Including art and chemical pottery, craquelle porcelain, faïence, garden vases, Grueby, Hampshire, Indian, Pewabic, and Teco pottery, Guernsey earthenware, handmade tile, hanging baskets, insulating materials, jardinieres, pins, stilts and spurs for potters' use; porcelain door knobs, filter disks and tubes, mouthpieces for speaking tubes, shuttle eyes and thread guides, porcelain hardware trimmings, porcelain lighting appliances, tobacco pipes, toy marbles, and turpentine cups.

[b] Included in "Other States."

[c] Included in [e] ($569,395).

[d] Includes all products made by less than three producers in one State.

[e] Made up of state totals of Connecticut, District of Columbia, Kansas, Louisiana, Maine, Minnesota, Montana, New Hampshire, New Mexico, Oregon, Porto Rico, and Utah. The total for "Other States" is distributed among the States to which it belongs.

The number of States and Territories reporting ware classed as pottery in this report in 1909 was 38. As in former years, however, the important producing States are few. General ware was reported from 9 States; sanitary ware from 9, an increase of 1—Illinois; and porcelain electrical supplies from 8, Pennsylvania entering the list of producers of this ware, and West Virginia dropping out.

Red earthenware was reported from 29 States and Territories, 1 less than in 1908. But as Porto Rico was added to the list, there were 2 States that reported this product less than in 1908, namely, Louisiana and Mississippi. Pennsylvania, which was the third State in value of this ware in 1908, was the leading State in 1909, reporting ware valued at $159,796, an increase of $21,615, or 15.64 per cent, as compared with $138,181 in 1908. Massachusetts, which was first in 1908, was second in 1909, reporting ware valued at $154,887, an increase of $4,739. Ohio, which was the leading State in 1906, with a product valued at $206,258, was third in 1909, reporting $145,137. Red earthenware was reported by 147 producers in 1909, 179 in 1908, and 193 in 1907. In 1909 it constituted 2.60 per cent of the total pottery products, and in 1908, 3.02 per cent.

Stoneware, including yellow and Rockingham ware, was reported by 28 States in 1908, and by 29 in 1909, Wisconsin entering the list in 1909. Ohio was the leading State, as for many years previous, and reported stoneware valued at $1,806,798, a gain of $338,601, or 23.06 per cent, in 1909, as compared with $1,468,197 in 1908. Illinois, as for several years, was second in 1909 and reported stoneware valued at $702,411, a loss of $30,962, or 4.22 per cent, as compared with $733,373 in 1908. The number of firms reporting this ware decreased from 209 in 1908 to 196 in 1909. This product was 12.86 per cent of the value of all pottery products in 1909 and 14 per cent in 1908.

As shown by these tables, the pottery products of greatest value are embraced under the heading white ware, though they are reported from but few States. The wares embraced under this head represent the general household wares and compose the larger portion of what is known as pottery. Ohio is, and has been for many years, the leading producer, reporting for 1909 an output valued at $8,884,189, or 64.71 per cent of the total value; in 1908 Ohio reported $7,228,636, or 63 per cent of the total value, an increase in 1909 of $1,655,553, or 22.90 per cent. West Virginia has been second in the value of this product for several years, and reported wares valued at $1,769,808, which was an increase of $157,487, or 9.77 per cent in 1909 over 1908, and of $118,076 over 1907. New Jersey was third in both years, reporting wares valued at $1,137,701 and $1,242,361 in 1908 and 1909, respectively; this was a gain of $104,660, or 9.20 per cent, over 1908, and was $16,670 greater than the output in 1907. White ware composed 44.21 per cent of the value of all pottery products in 1909; 45.65 in 1908; and 46.16 per cent in 1907. The number of producers reporting white ware decreased from 65 in 1908 to 62 in 1909; in 1907 there were 68 producers.

In the output of china in its several varieties, which is produced in only 4 States, New Jersey is the leader, reporting wares valued in 1909 at $1,082,398, or 61.26 per cent of the total, a gain of $206,139, or 23.52 per cent, over 1908, but a loss of $53,487 from the output of 1907. China was reported by 14 operators from 4 States, a decrease of 2 in the number of operators from 1908. It constitutes but a small proportion of the value of pottery products, furnishing only 5.69 per cent in 1909 and 6.29 per cent in 1908.

Only 9 States reported sanitary ware for 1909, Illinois and Maryland being added to the list, and Montana dropping out. New Jersey continued to be by far the largest producer, reporting sanitary ware valued at $4,341,040, or 72.48 per cent of the total in 1909. This was an increase of $1,158,268, or 36.39 per cent over 1908, and was $725,355 more than the value of this product in 1907, and $598,995 more than in 1906, the year of maximum production to that time. West Virginia was second in value of this product in 1908 and 1909, and showed an increase from $385,000 in the former year to $500,432, a gain of $115,432, or 29.98 per cent. The other States for which figures are given also showed increases. The number of producers decreased 1 in 1909. Sanitary ware was 19.29 per cent of the value of the total pottery products in 1909 and 17.40 per cent in 1908.

Porcelain electrical supplies were reported from 8 States for 1909; in only 3, however, was the number of producers requisite to permit publication of figures. Those States where it is necessary to conceal the figures are of but little importance, as they reported only a little over 10 per cent of the total. Ohio is the largest producer, and reported 37.63 per cent of the entire product. Ohio's output increased 59.48 per cent in 1909 over 1908. This material composed 9.82 per cent of all pottery products in 1909 and 7.99 per cent in 1908.

As for many years, Ohio continued to be the leading pottery-producing State of the Union, reporting for 1909 wares valued at $13,416,356, or 43.21 per cent of the total. This was an increase of $2,709,569, or 25.31 per cent over the output of 1908, when Ohio produced 42.60 per cent of the total. New Jersey was second in 1909, with wares valued at $7,791,136, or 25.09 per cent of the total, an increase of $1,841,145, or 30.94 per cent. West Virginia was third, reporting wares valued at $2,350,470, or 7.57 per cent of the total, a gain of only $266,649, or 12.80 per cent. New York was fourth and Pennsylvania was fifth in both 1908 and 1909.

Illinois, which was sixth in 1908, and Indiana, which was seventh, exchanged places in relative rank in 1909, Illinois becoming seventh and Indiana sixth, with 2.70 and 2.90 per cent of the total, respectively. The first 5 States, Ohio, New Jersey, West Virginia, New York, and Pennsylvania, produced 87.69 per cent of the total.

TRENTON, N. J., AND EAST LIVERPOOL, OHIO.

New Jersey and Ohio are the leading pottery-producing States, reporting 68.30 per cent of the value of all pottery produced in the United States in 1909. Each of these 2 States has a pottery center. In New Jersey it is at Trenton, where 92.10 per cent of the total of the State was produced in 1909; and in Ohio at East Liverpool, where 41.28 per cent of the State total was produced. In 1908 these cities produced 94.95 and 37.83 per cent of the pottery of their States, respectively. The whiteware industry in New Jersey is practically confined to Trenton; in Ohio, although East Liverpool is the great producing center, much whiteware is produced outside of that city.

As, however, these two cities are the leading pottery centers of the country, the following table has been prepared showing the details of production in them:

Value of pottery products of Trenton, N. J., and East Liverpool, Ohio, in 1908 and 1909, by varieties.

Variety.	1908.			1909.		
	Trenton.	East Liverpool.	Total.	Trenton.	East Liverpool.	Total.
Stoneware and yellow and Rockingham ware	....	$70,010	$70,010	....	$89,803	$89,803
White ware, C. C. ware, white granite, semiporcelain ware, and semivitreous porcelain ware	$1,137,701	3,539,683	4,677,384	$1,242,361	4,578,390	5,820,751
China, bone china, delft, and belleek ware	876,259	....	876,259	1,082,398	....	1,082,398
Sanitary ware	2,997,148	....	2,997,148	3,944,597	....	3,944,597
Porcelain electrical supplies	559,556	307,109	866,665	807,491	712,461	1,519,952
Miscellaneous [a]	78,808	133,582	212,390	98,954	158,216	257,170
Total	5,649,472	4,050,384	9,699,856	7,175,801	5,538,870	12,714,671
Per cent of total pottery product	22.48	16.11	38.59	23.11	17.83	40.94

[a] Including porcelain door knobs and lighting appliances; hardware supplies, and pins, stilts, and spurs for potters' use.

The table shows that these two cities are large producers of pottery. The balance in favor of Trenton in 1909 was $1,636,931, which makes Trenton's product 29.55 per cent greater than that of East Liverpool; in 1908 this balance was $1,599,088, or 39.48 per cent, in favor of Trenton. In 1901 the difference in value of pottery products of these cities was only $13,036; this difference in favor of Trenton has been steadily increasing since 1905, when it was $183,232. It seems only fair to East Liverpool to say that if the plants in its neighborhood, both in Ohio and West Virginia, that have been the natural outgrowth of the industry at East Liverpool were included with that city it would exceed Trenton in the value of its pottery products.

There has been no change in the character of the wares made in these cities, which produced 40.94 per cent of the pottery products of the entire country in 1909, 38.59 per cent in 1908, and 40.63 per cent in 1907.

CONSUMPTION.

The pottery imported into the United States in 1909 was valued at $10,607,212, and the production at $31,049,441, a total of $41,656,653. After deducting the exports—domestic $863,695 and foreign $39,448—the net consumption was $40,753,510, of which the domestic production was 76.19 per cent. This is the highest proportion ever reached; the next highest was in 1902, when it was 72.91.

IMPORTS AND EXPORTS.

The following table shows the imports of clay products from 1905 to 1909:

Value of earthenware, china, brick, and tile imported and entered for consumption in the United States, 1905–1909.

Year.	Pottery.				Brick, fire brick, tile, etc.	Grand total.
	Brown earthen and common stone ware.[a]	China and porcelain, not decorated.	China and porcelain, decorated.	Total.		
1905	$100,618	$1,157,573	$10,717,871	$11,976,062	$172,079	$12,148,141
1906	96,400	1,312,326	11,822,376	13,231,102	175,797	13,406,899
1907	113,477	1,315,591	12,156,544	13,585,612	225,320	13,810,932
1908	70,629	1,142,444	9,309,718	10,522,791	162,341	10,685,132
1909	98,716	1,245,479	9,263,017	10,607,212	189,536	10,796,748

[a] Including Rockingham ware.

The imports of all clay products increased in value in 1909 only $111,616, or 1.04 per cent; in 1908 there was a decrease from the imports of 1907 of $3,125,800. It will be noted that 98.24 per cent of the clay product imports was pottery in 1909, only 1.76 per cent being brick and tile, and that of the pottery imports 99.07 per cent was general ware and 0.93 per cent of the lower grades. Stoneware and plain white ware showed a gain of $131,122, while decorated white ware fell off $46,701, the net increase in pottery imports being only $84,421, or less than 1 per cent. The brick imports increased in 1909 $27,195, or 16.75 per cent; they decreased in 1908 $62,979, or 27.95 per cent.

The following table shows the exports of clay products of domestic manufacture from the United States from 1905 to 1909, inclusive:

Exports of clay wares of domestic manufacture from the United States, 1905–1909.

Year.	Brick.				Pottery.			Grand total (value).
	Building.		Fire (value).	Total (value).	Earthen and stone ware. (value).	China (value).	Total (value).	
	Quantity (thousands).	Value.						
1905	34,242	$263,876	$536,002	$799,878	$882,069	$101,485	$983,554	$1,783,432
1906	27,758	247,625	637,441	885,066	1,003,969	114,481	1,118,450	2.003,516
1907	22,340	185,192	631,779	816,971	1,022,730	108,911	1,131,641	1,948,612
1908	12,038	113,243	[a] 550,243	663,486	906,266	77,494	983,760	1,647,246
1909	15,428	147,622	1,002,270	1,149,892	776,842	86,853	863,695	2,013,587

[a] Includes all brick other than building brick.

The exports of domestic clay products increased in value $366,341, or 22.24 per cent, in 1909; in 1908 they decreased $301,366, or 15.47 per cent. Brick and tile exports gained $486,406, or 73.31 per cent, in 1909, of which increase fire brick furnished $452,027, or 92.93 per cent, and building brick $34,379, or 7.07 per cent. The average value per thousand of the building brick exported in 1909 was $9.57; in 1908 it was $9.41; and in 1907, $8.29. Of the pottery exports the high-grade wares constituted 10.06 per cent and the lower grades 89.94 per cent; in 1908 these percentages were 7.88 and 92.12, respectively.

CLAY PRODUCTS IN VARIOUS STATES.

The following table gives the statistics of clay products from 1905 to 1909, inclusive, for some of the more important clay-working States, and will be of interest to those who desire to compare the growth of the industries in these States for several years. Owing to the changes in the classification of the products in some of the minor items, the figures do not always represent solely the values of the products named, though the classification as given in the tables is the nearest that can be made without reconstructing them entirely. The item "Miscellaneous" under each State includes all products not otherwise classified and those that could not be published separately without disclosing individual returns.

Clay products of the United States, by States, from 1905 to 1909.

ALABAMA.

Product.	1905.	1906.	1907.	1908.	1909.
Brick:					
Common—					
Quantity	158,801,000	166,225,000	159,315,000	120,237,000	146,180,000
Value	$930,568	$1,046,986	$1,004,644	$690,963	$799,693
Average per M	$5.86	$6.30	$6.31	$5.75	$5.47
Vitrified—					
Quantity	(a)	(a)	13,362,000	18,248,000	20,444,000
Value	(a)	(a)	$183,895	$244,084	$262,376
Average per M	$13.29	$11.62	$13.76	$13.38	$12.83
Front—					
Quantity	(a)	(a)	(a)	(a)	(a)
Value	(a)	(a)	(a)	(a)	(a)
Average per M	$11.20	$11.35	$13.90	$17.89	$16.19
Fancy ... value	....	....	(a)	(a)	(a)
Fire ... do	$125,244	$157,147	$170,711	$122,354	$196,887
Drain tile ... do	(a)	$2,285	(a)	$2,046	(a)
Sewer pipe ... do	(a)	(a)	(a)	(a)	(a)
Fireproofing ... do	....	(a)	(a)	(a)	(a)
Pottery:					
Red earthenware ... do	$2,700	$2,620	$7,530	$15,058	$11,886
Stoneware and yellow and Rockingham ware ... value	$31,545	$35,376	$20,215	$9,031	$24,453
Miscellaneous ... do	$302,814	$444,485	$367,414	$476,070	$404,832
Total value	$1,392,871	$1,688,899	$1,754,409	$1,559,606	$1,700,127
Number of operating firms reporting	111	112	100	103	100
Rank of State	23	21	20	19	22

a Included in "Miscellaneous."

Clay products of the United States, by States, from 1905 to 1909—Continued.

CALIFORNIA.

Product.	1905.	1906.	1907.	1908.	1909.
Brick:					
Common—					
Quantity	284,205,000	278,780,000	339,439,000	236,383,000	276,396,000
Value	$1,961,909	$1,962,866	$2,483,062	$1,593,814	$1,749,209
Average per M	$6.90	$7.05	$7.32	$6.74	$6.33
Vitrified—					
Quantity	(a)	(a)	(a)	3,499,000	7,180,000
Value	(a)	(a)	(a)	$66,214	$135,203
Average per M	$19.23	$18.49	$15.79	$18.92	$18.83
Front—					
Quantity	11,871,000	18,421,000	12,922,000	12,393,000	10,359,000
Value	$302,872	$501,746	$283,375	$283,701	$309,770
Average per M	$25.51	$27.24	$21.93	$22.89	$29.90
Fancy or ornamental..value..	$31,899	(a)	$150,165	$34,947	(a)
Enameled..do....	(a)	(a)	(a)	(a)	$57,914
Fire..do....	$290,878	$347,806	$374,378	$325,760	$297,577
Stove lining..do....	(a)	(a)	(a)	(a)	(a)
Drain tile..do....	$27,852	$30,545	$53,997	$34,457	$29,620
Sewer pipe..do....	$663,044	$827,477	$1,086,916	$1,036,320	$904,473
Architectural terra cotta..do....	$215,160	$254,932	$528,623	$500,130	$345,402
Fireproofing..do....	$114,665	$130,568	$208,205	$188,221	$128,447
Tile, not drain..do....	$34,679	$69,023	$107,492	$84,484	$130,941
Pottery:					
Red earthenware..do....	$41,547	$37,781	$42,856	$42,962	$42,464
Stoneware and yellow and Rockingham ware..value..	$11,812	$25,199	$39,382	$29,300	$59,907
Sanitary ware..do....	(a)	(a)	(a)	(a)	(a)
Miscellaneous..do....	$168,830	$176,287	$382,086	$303,435	$246,238
Total value	$3,865,147	$4,364,230	$5,740,537	$4,523,745	$4,437,165
Number of operating firms reporting	122	113	118	119	99
Rank of State	8	8	8	8	9

COLORADO.

Product.	1905.	1906.	1907.	1908.	1909.
Brick:					
Common—					
Quantity	96,058,000	120,944,000	118,551,000	112,859,000	121,908,000
Value	$638,376	$787,084	$803,701	$795,733	$801,833
Average per M	$6.65	$6.51	$6.78	$7.05	$6.58
Vitrified—					
Quantity	5,083,000	6,239,000	3,145,000	2,372,000	(a)
Value	$51,240	$74,460	$37,782	$30,262	(a)
Average per M	$10.08	$11.93	$12.01	$12.76	$14.12
Front—					
Quantity	23,520,000	24,147,000	24,572,000	31,667,000	38,782,000
Value	$253,277	$256,770	$254,522	$364,367	$473,039
Average per M	$10.77	$10.63	$10.36	$11.51	$12.20
Fancy..value..	$8,404	$2,806	$46,128	$34,777	....
Enameled..do....	(a)	(a)	(a)	....	....
Fire..do....	$274,095	$278,407	$430,897	$206,161	$265,089
Drain tile..do....	$14,185	$6,126	$19,608	$16,472	$13,626
Sewer pipe..do....	(a)	(a)	(a)	(a)	(a)
Architectural terra cotta..do....	(a)	(a)	(a)	(a)	....
Fireproofing..do....	(a)	(a)	(a)	(a)	(a)
Tile, not drain..do....	(a)	$40,640	(a)	(a)	(a)
Pottery:					
Red earthenware..do....	$6,891	$9,077	$1,931	$11,250	(a)
Stoneware and yellow and Rockingham ware..value..	(a)	$26,266	$35,644	(a)	(a)
Miscellaneous..do....	$386,763	$349,452	$411,262	$511,059	$495,437
Total value	$1,633,231	$1,831,088	$2,041,475	$1,970,081	$2,049,024
Number of operating firms reporting	94	94	88	80	73
Rank of State	19	19	16	15	16

a Included in "Miscellaneous."

Clay products of the United States, by States, from 1905 to 1909—Continued.

CONNECTICUT AND RHODE ISLAND.

Product.	1905.	1906.	1907.	1908.	1909.
Brick:					
Common—					
Quantity	211,613,000	212,648,000	198,414,000	131,760,000	242,000,000
Value	$1,329,220	$1,503,929	$1,240,575	$749,093	$1,408,033
Average per M	$6.28	$7.07	$6.25	$5.69	$5.82
Vitrified—					
Quantity	(a)	(a)	(a)	(a)	(a)
Value	(a)	(a)	(a)	(a)	(a)
Average per M	$19.00	$16.36	$24.23	$16.25	$13.00
Front—					
Quantity	(a)	(a)	(a)	(a)	(a)
Value	(a)	(a)	(a)	(a)	(a)
Average per M	$14.01	$16.51	$15.44	$15.75	$14.00
Fancy or ornamental.value	(a)				(a)
Fire.do	(a)	(a)	(a)	(a)	(a)
Stove lining.do	(a)	(a)	(a)	(a)	(a)
Fireproofing.do		(a)			
Pottery: [b]					
Red earthenware.do	(a)	(a)	(a)	(a)	(b)
Stoneware and yellow and Rockingham ware..value	(a)	(a)	(a)	(a)	(b)
Porcelain electrical supplies, value	(a)	(a)	(a)	(a)	(b)
Miscellaneous.value	$279,358	$243,276	$244,017	$152,468	$107,562
Total value	$1,608,578	$1,747,205	$1,484,592	$901,561	$1,515,595
Number of operating firms reporting	42	42	43	41	42
Rank of Connecticut and Rhode Island	20	20	24	27	24

GEORGIA.

Product.	1905.	1906.	1907.	1908.	1909.
Brick:					
Common—					
Quantity	275,841,000	303,286,000	318,844,000	248,585,000	275,809,000
Value	$1,444,479	$1,783,988	$1,807,148	$1,335,349	$1,469,839
Average per M	$5.24	$5.88	$5.67	$5.37	$5.33
Vitrified—					
Quantity	(a)	(a)	(a)	(a)	(a)
Value	(a)	(a)	(a)	(a)	(a)
Average per M	$14.00	$13.99	$12.50	$15.50	$12.00
Front—					
Quantity	2,667,000	2,094,000	1,625,000	2,929,000	7,188,000
Value	$28,676	$20,747	$16,450	$34,385	$61,131
Average per M	$10.75	$9.91	$10.12	$11.74	$8.50
Fancy or ornamental.value			(a)		(a)
Fire.do	$73,050	$51,310	$82,391	$53,466	$62,452
Stove lining.do			(a)		
Draintile.do	$13,500	$12,000	$8,050	(a)	$4,820
Sewer pipe.do	$218,000	$221,000	$244,000	$253,664	$351,492
Architectural terra cotta.do	(a)	(a)	(a)	(a)	(a)
Fireproofing.do	(a)	(a)	(a)	(a)	(a)
Tile, not drain.do	(a)	(a)	(a)	(a)	(a)
Pottery:					
Red earthenware.do	$5,512	$5,345	$18,440	$5,710	$12,945
Stoneware and yellow and Rockingham ware..value	$16,378	$14,912	$15,445	$4,941	$16,435
Miscellaneous.do	$320,151	$291,322	$298,313	$241,096	$315,387
Total value	$2,119,746	$2,400,624	$2,490,237	$1,928,611	$2,294,501
Number of operating firms reporting	95	99	106	108	105
Rank of State	12	13	13	16	15

[a] Included in "Miscellaneous."

[b] Produced by Connecticut alone. In 1909 the value of pottery products for Connecticut could not be included in the State totals without disclosing the operations of individual establishments.

Clay products of the United States, by States, from 1905 to 1909—Continued.

ILLINOIS.

Product.	1905.	1906.	1907.	1908.	1909.
Brick:					
Common—					
Quantity	1,125,024,000	1,195,210,000	1,494,807,000	1,119,224,000	1,257,025,000
Value	$6,259,232	$5,719,906	$6,499,777	$4,834,652	$5,927,054
Average per M	$5.56	$4.79	$4.35	$4.32	$4.72
Vitrified—					
Quantity	90,563,000	122,227,000	126,927,000	138,362,000	140,105,000
Value	$973,247	$1,306,476	$1,405,821	$1,622,496	$1,562,373
Average per M	$10.75	$10.69	$11.08	$11.73	$11.15
Front—					
Quantity	30,447,000	30,022,000	20,828,000	22,851,000	32,416,000
Value	$348,354	$341,298	$266,270	$301,515	$385,170
Average per M	$11.44	$11.37	$12.78	$13.19	$11.88
Fancy or ornamental . value	$13,567	$11,635	(a)	(a)	$12,223
Enameled . do	(a)	(a)	(a)	(a)	(a)
Fire . do	$176,692	$236,032	$241,008	$250,444	$682,793
Stove lining . do	....	(a)	(a)	(a)	....
Draintile . do	$1,051,852	$1,052,588	$1,031,192	$1,421,878	$1,613,593
Sewer pipe . do	$580,538	$587,805	$662,487	$514,386	$394,461
Architectural terra cotta . do	(a)	(a)	(a)	(a)	$1,898,865
Fireproofing . do	$339,126	$416,928	$429,535	$264,986	$439,796
Tile, not drain . do	(a)	(a)	(a)	$124,425	$335,020
Pottery:					
Red earthenware . do	$25,350	$37,543	$37,045	$24,821	$31,771
Stoneware and yellow and Rockingham ware . value	$895,407	$897,650	$898,267	$733,373	$702,411
White ware, including C. C. ware, white granite, semi-porcelain ware, and semi-vitreous porcelain ware, value	....	(a)	(a)	(a)	(a)
Sanitary ware . value	....	....	....	....	(a)
Porcelain electrical supplies, value	....	(a)	(a)	....	....
Miscellaneous . value	$1,698,421	$2,026,320	$1,749,087	$1,466,138	$358,923
Total value	$12,361,786	$12,634,181	$13,220,489	$11,559,114	$14,344,453
Number of operating firms reporting	469	466	417	400	379
Rank of State	5	5	4	4	4

a Included in "Miscellaneous."

Clay products of the United States, by States, from 1905 to 1909—Continued.

INDIANA.

Product.	1905.	1906.	1907.	1908.	1909.
Brick:					
Common—					
Quantity	279,073,000	307,076,000	251,766,000	224,454,000	251,227,000
Value	$1,630,072	$1,778,270	$1,509,415	$1,221,910	$1,579,185
Average per M	$5.84	$5.79	$6.00	$5.44	$6.29
Vitrified—					
Quantity	43,573,000	45,725,000	46,224,000	57,748,000	53,597,000
Value	$474,600	$502,509	$548,448	$776,533	$559,201
Average per M	$10.89	$10.99	$11.87	$13.45	$10.44
Front—					
Quantity	22,212,000	35,090,000	36,890,000	34,336,000	50,135,000
Value	$231,353	$395,368	$437,796	$403,545	$511,171
Average per M	$10.42	$11.27	$11.87	$11.75	$10.20
Fancy or ornamental . value	$15,520	$4,700	(a)	(a)	(a)
Fire . do	$163,728	$149,351	$160,373	$115,895	$280,921
Stove lining . do	(a)	(a)			
Draintile . do	$1,267,691	$1,373,441	$1,437,735	$1,797,329	$2,018,401
Sewer pipe . do	$430,680	$486,897	$487,537	$486,946	$332,449
Architectural terra cotta . do	(a)	(a)	(a)	(a)	(a)
Fireproofing . do	$544,592	$422,419	$414,343	$359,817	$410,500
Tile, not drain . do	(a)	(a)	(a)	$505,908	(a)
Pottery:					
Red earthenware . do	$5,397	$6,550	$5,075	$7,450	$10,090
Stoneware and yellow and Rockingham ware . value	$69,115	$66,774	$45,579	$37,020	$59,598
Whiteware, including C. C. ware, white granite, semi-porcelain ware, and semi-vitreous porcelain ware, value	(a)	(a)	(a)	(a)	(a)
Sanitary ware . value	$496,000	$435,000	$400,000	$350,000	(a)
Porcelain electrical supplies, value	(a)	(a)	(a)	(a)	(a)
Miscellaneous . value	$1,170,825	$1,536,955	$1,411,823	$677,814	$1,883,707
Total value	$6,499,573	$7,158,234	$6,858,124	$6,740,167	$7,645,223
Number of operating firms reporting	441	419	392	369	348
Rank of State	6	6	7	6	6

IOWA.

Product.	1905.	1906.	1907.	1908.	1909.
Brick:					
Common—					
Quantity	193,259,000	168,871,000	157,618,000	135,678,000	153,065,000
Value	$1,366,653	$1,118,709	$1,085,383	$904,308	$1,072,340
Average per M	$7.07	$6.62	$6.89	$6.67	$7.01
Vitrified—					
Quantity	13,253,000	16,930,000	21,686,000	16,672,000	18,586,000
Value	$134,802	$185,990	$223,193	$185,112	$198,780
Average per M	$10.17	$10.99	$10.29	$11.10	$10.70
Front—					
Quantity	5,676,000	8,871,000	8,028,000	7,900,000	12,015,000
Value	$60,669	$101,795	$96,316	$86,232	$138,218
Average per M	$10.69	$11.48	$12.00	$10.92	$11.50
Fancy or ornamental . value				(a)	(a)
Fire . do	$869	$930	$795		(a)
Draintile . do	$1,509,226	$1,721,614	$2,011,793	$2,509,505	$2,830,910
Sewer pipe . do	(a)	(a)	(a)	$211,044	$282.637
Fireproofing, terra-cotta lumber, and hollow building block or tile . value	$137,554	$162,664	$176,854	$129,003	$304,398
Tile, not drain . do	(a)				
Pottery:					
Red earthenware . do	$9,400	$10,100	$8,250	$8,161	$8,175
Stoneware and yellow and Rockingham ware . value	$59,459	(a)	(a)	$7,549	(a)
Miscellaneous . do	$113,490	$167,225	$126,201	$28,583	$63,238
Total value	$3,392,122	$3,469,027	$3,728,785	$4,069,497	$4,898,696
Number of operating firms reporting	306	304	276	263	247
Rank of State	9	9	9	9	8

a Included in "Miscellaneous."

Clay products of the United States, by States, from 1905 to 1909—Continued.

KANSAS.

Product.	1905.	1906.	1907.	1908.	1909.
Brick:					
Common—					
Quantity	214,273,000	314,371,000	263,887,000	225,820,000	254,890,000
Value	$917,084	$1,376,552	$1,189,263	$896,542	$1,160,877
Average per M	$4.28	$4.38	$4.51	$3.97	$4.55
Vitrified—					
Quantity	75,826,000	78,199,000	85,110,000	102,922,000	103,264,000
Value	$580,695	$658,392	$727,979	$862,019	$932,419
Average per M	$7.66	$8.42	$8.55	$8.38	$9.03
Front—					
Quantity	18,743,000	19,875,000	24,381,000	29,477,000	26,170,000
Value	$180,201	$187,577	$236,876	$233,578	$235,875
Average per M	$9.61	$9.44	$9.72	$7.92	$9.01
Fancy or ornamental.value	$17,010	(a)	(a)	(a)	(a)
Fire.....do	$7,334	(a)	(a)	(a)	(a)
Draintile.....do	$13,212	$19,694	$15,320	$22,359	$37,862
Sewer pipe.....do	(a)	(a)	(a)	(a)	(a)
Architectural terra cotta..do	(a)	....	(a)	(a)	(a)
Fireproofing.....do	$6,802	(a)	(a)	(a)	(a)
Tile, not drain.....do	(a)	(a)	(a)	(a)	(a)
Pottery:					
Stoneware and yellow and Rockingham ware..value	(b)	(b)	(b)	(b)	(b)
Miscellaneous.....do	$184,022	$190,156	$200,620	$234,307	$342,789
Total value	$1,906,360	$2,432,371	$2,370,058	$2,248,805	$2,709,822
Number of operating firms reporting	68	66	67	65	58
Rank of State	16	12	14	11	13

KENTUCKY.

Product.	1905.	1906.	1907.	1908.	1909.
Brick:					
Common—					
Quantity	147,702,000	142,185,000	143,731,000	110,545,000	119,183,000
Value	$862,330	$881,879	$932,469	$687,365	$741,115
Average per M	$5.84	$6.20	$6.49	$6.22	$6.22
Vitrified—					
Quantity	(a)	(a)	(a)	(a)	(a)
Value	(a)	(a)	(a)	(a)	(a)
Average per M	$14.27	$14.13	$14.27	$13.26	$12.69
Front—					
Quantity	11,558,000	11,893,000	7,926,000	11,067,000	11,626,000
Value	$128,777	$109,771	$86,568	$119,785	$104,022
Average per M	$11.14	$9.23	$10.92	$10.82	$8.95
Fancy.....value	....	....	....	....	(a)
Fire.....do	$739,059	$898,527	$940,415	$770,221	$899,363
Stove lining.....do	....	....	....	....	(a)
Draintile.....do	$28,865	$27,359	$32,723	$53,308	$53,213
Sewer pipe.....do	(a)	(a)	(a)	(a)	(a)
Architectural terra cotta..do	(a)	....	....	....	(a)
Fireproofing.....do	....	(a)	(a)	$7,263	(a)
Tile, not drain.....do	$296,949	$296,391	$255,054	$215,000	$296,179
Pottery:					
Red earthenware.....do	$22,674	$26,637	$27,546	$23,448	$20,225
Stoneware and yellow and Rockingham ware..value	$134,409	$140,572	$139,075	$130,200	$126,172
Miscellaneous.....do	$193,287	$211,287	$197,514	$232,518	$238,583
Total value	$2,406,350	$2,592,423	$2,611,364	$2,239,108	$2,478,872
Number of operating firms reporting	121	117	115	116	99
Rank of State	10	11	11	12	14

a Included in "Miscellaneous."

b The value of pottery products for Kansas could not be included in the State totals without disclosing the operations of individual establishments.

Clay products of the United States, by States, from 1905 to 1909—Continued.

MARYLAND.

Product.	1905.	1906.	1907.	1908.	1909.
Brick:					
Common—					
Quantity	210,446,000	204,238,000	166,768,000	141,071,000	148,673,000
Value	$1,423,663	$1,267,771	$1,026,922	$828,981	$914,420
Average per M	$6.76	$6.21	$6.16	$5.88	$6.15
Vitrified—					
Quantity	(a)	(a)	(a)	(a)	(a)
Value	(a)	(a)	(a)	(a)	(a)
Average per M	$17.96	$15.60	$15.00	$13.06	$13.10
Front—					
Quantity	1,426,000	2,266,000	1,597,000	936,000	1,350,000
Value	$24,118	$31,968	$19,854	$13,498	$20,582
Average per M	$16.91	$14.11	$12.43	$14.42	$15.25
Fancy or ornamental value	(a)	(a)	(a)	$1,463	(a)
Enameled do	(a)	(a)	(a)	(a)	(a)
Fire do	$224,667	$266,980	$242,312	$179,469	$278,777
Stove lining do	$32,890	$32,200	$31,048	$23,538	$25,925
Draintile do	$1,703	$3,315	$3,190	$3,895	$5,695
Architectural terra cotta do	(a)	(a)	(a)	(a)	(a)
Tile, not drain do	(a)	(a)	(a)	(a)	....
Pottery:					
Red earthenware do	$13,325	$12,733	$12,895	$9,267	$8,031
Stoneware and yellow and Rockingham ware value	(a)	(a)	(a)	(a)	(a)
White ware, including C. C., white granite, semiporcelain and semivitreous porcelain ware value	$345,000	$352,000	$348,890	(a)	(a)
Sanitary ware do	....	....	....	....	(a)
Miscellaneous do	$181,001	$169,572	$201,251	$380,988	$467,379
Total value	$2,249,367	$2,136,539	$1,886,362	$1,441,099	$1,720,812
Number of operating firms reporting	68	70	63	65	59
Rank of State	11	15	18	22	21

MASSACHUSETTS.

Product.	1905.	1906.	1907.	1908.	1909.
Brick:					
Common—					
Quantity	194,504,000	204,282,000	184,005,000	141,591,000	183,584,000
Value	$1,264,787	$1,415,864	$1,294,918	$950,921	$1,177,281
Average per M	$6.50	$6.93	$7.04	$6.72	$6.41
Front—					
Quantity	2,080,000	(a)	(a)	1,899,000	1,790,000
Value	$33,971	(a)	(a)	$34,055	$45,050
Average per M	$16.33	$22.17	$37.13	$17.93	$25.17
Fancy or ornamental value	(a)	(a)	(a)	(a)	(a)
Fire do	$68,180	$57,940	$74,115	$63,241	$75,160
Stove lining do	$173,151	$186,815	$206,042	$169,811	$159,530
Architectural terra cotta do	(a)	(a)	(a)	....	(a)
Fireproofing do	(a)	(a)	(a)	(a)	(a)
Tile, not drain do	$82,000	$91,394	$123,220	$104,386	$69,837
Pottery:					
Red earthenware do	$185,074	$171,160	$166,978	$150,148	$154,887
Stoneware and yellow and Rockingham ware value	$23,876	$18,210	$17,693	$15,409	$14,380
White ware, including C. C. ware, white granite ware, semiporcelain and semivitreous porcelain ware, value	(a)	(a)	(a)	(a)	(a)
Porcelain electrical supplies, value	....	(a)	(a)	(a)	(a)
Miscellaneous value	$219,418	$231,350	$245,854	$159,391	$191,761
Total value	$2,050,457	$2,172,733	$2,128,820	$1,647,362	$1,887,886
Number of operating firms reporting	78	82	80	76	72
Rank of State	13	14	15	18	19

a Included in "Miscellaneous."

Clay products of the United States, by States, from 1905 to 1909—Continued.

MICHIGAN.

Product.	1905.	1906.	1907.	1908.	1909.
Brick:					
Common—					
Quantity	211,558,000	[illegible]	[illegible]	[illegible]	[illegible]
Value	$1,152,508	$1,178,202	[illegible]	$844,525	$1,250,757
Average per M	$5.45	$5.77	$5.88	$5.49	[illegible]
Vitrified—					
Quantity	4,112,000	6,229,000	[illegible]	[illegible]	10,471,000
Value	$55,706	$81,514	$84,001	[illegible]	$129,283
Average per M	$13.37	$13.13	[illegible]	[illegible]	$12.34
Front—					
Quantity	663,000	1,474,000	[illegible]	[illegible]	[illegible]
Value	$5,995	$14,002	[illegible]	[illegible]	[illegible]
Average per M	$8.05	$9.50	$8.12	$10.28	$7.34
Fancy or ornamental ..value		(a)			
Fire ..do	(a)	(a)	(a)		
Stove lining ..do	(a)	(a)			
Draintile ..do	$265,445	$314,965	[illegible]	[illegible]	$394,106
Sewer pipe ..do	(a)	(a)	(a)	(a)	(a)
Fireproofing, terra-cotta lumber, and hollow building tile, or blocks ..value	$3,785	$4,250	[illegible]	[illegible]	(a)
Tile, not drain ..do			(a)	(a)	(a)
Pottery:					
Red earthenware ..do	(a)	$42,530	[illegible]	[illegible]	$40,838
White ware, including C. C. ware, white granite ware, semiporcelain and semivitreous porcelain ware, value	(a)				
Miscellaneous ..value	$326,271	$298,401	[illegible]	[illegible]	$215,829
Total value	$1,755,707	$1,944,477	[illegible]	$1,725,790	$2,042,488
Number of operating firms reporting	154	142	136	132	122
Rank of State	17	13	19	17	17

MINNESOTA.

Product.	1905.	1906.	1907.	1908.	1909.
Brick:					
Common—					
Quantity	166,236,000	163,398,000	158,921,000	143,712,000	161,353,000
Value	$977,437	$959,852	$1,045,574	$849,321	$946,729
Average per M	$5.88	$5.90	$6.58	$5.87	$6.00
Vitrified—					
Quantity	(a)	(a)	(a)	(a)	(a)
Value	(a)	(a)	(a)	(a)	(a)
Average per M	$14.34	$20.06	$12.00	$9.00	$9.00
Front—					
Quantity	6,636,000	7,330,000	(a)	[illegible]	14,137,000
Value	$85,300	$98,170	(a)	[illegible]	[illegible]
Average per M	$12.85	$13.37	$12.48	$12.82	$12.90
Fancy or ornamental ..value			(a)	(a)	
Fire ..do	(a)	(a)	(a)	(a)	
Draintile ..do	$25,770	$41,773	$46,822	$75,190	$106,221
Sewer pipe ..do	(a)	(a)	(a)	(a)	(a)
Fireproofing ..do	(a)	$23,392	$42,327	$45,440	$55,398
Tile, not drain ..do					(a)
Pottery:					
Earthenware and stoneware, value	(b)	(b)	(b)	(b)	(b)
Miscellaneous ..value	$420,479	$452,337	$552,070	$494,217	$435,340
Total value	$1,499,386	$1,603,279	$1,686,393	$1,508,718	$1,733,438
Number of operating firms reporting	111	109	106	92	80
Rank of State	21	23	21	20	20

a Included in "Miscellaneous."
b The value of pottery products for Minnesota could not be included in the State totals without disclosing the operations of individual establishments.

Clay products of the United States, by States, from 1905 to 1909—Continued.

MISSOURI.

Product.	1905.	1906.	1907.	1908.	1909.
Brick:					
Common—					
Quantity	316,002,000	257,292,000	264,462,000	219,526,000	276,403,000
Value	$2,028,957	$1,810,304	$1,844,255	$1,465,311	$1,961,805
Average per M	$6.42	$7.04	$6.97	$6.67	$7.10
Vitrified—					
Quantity	43,375,000	57,414,000	47,807,000	56,805,000	59,863,000
Value	$470,935	$539,700	$462,341	$647,097	$781,706
Average per M	$10.86	$9.40	$9.67	$11.39	$1,306
Front—					
Quantity	28,224,000	29,019,000	30,178,000	32,136,000	36,194,000
Value	$362,996	$394,563	$387,455	$356,758	$589,782
Average per M	$12.86	$13.59	$12.84	$11.10	$1,630
Fancy or ornamental.value	$44,632	$30,689	$33,638	$25,035	$29,683
Enameled.....do	(a)	(a)	(a)	(a)	(a)
Fire.....do	$1,117,209	$1,324,895	$1,634,209	$1,357,387	$1,598,302
Stove lining.....do	(a)	(a)	(a)	(a)	(a)
Draintile.....do	$59,858	$64,063	$72,316	$76,865	$127,166
Sewer pipe.....do	$1,101,938	$1,208,236	$1,332,080	$962,116	$1,162,730
Architectural terra cotta...do	(a)	(a)	(a)	(a)	(a)
Fireproofing, terra-cotta lumber, and hollow building tile or blocks.....value	$62,694	$130,914	$142,997	$105,136	$110,464
Tile, not drain.....do	(a)	(a)	(a)	(a)	(a)
Pottery:					
Red earthenware.....do	$4,054	$4,429	$3,289	$3,719	$4,792
Stoneware and yellow and Rockingham ware..value	$39,314	$65,071	$69,323	$62,689	$66,830
Miscellaneous.....do	$910,824	$1,123,411	$916,968	$569,343	$1,006,923
Total value	$6,203,411	$6,696,275	$6,898,871	$5,631,456	$7,440,183
Number of operating firms reporting	224	190	172	161	156
Rank of State	7	7	6	7	7

NEBRASKA.

Product.	1905.	1906.	1907.	1908.	1909.
Brick:					
Common—					
Quantity	131,290,000	119,501,000	117,276,000	114,399,000	139,151,000
Value	$874,695	$835,702	$789,170	$766,146	$946,532
Average per M	$6.66	$6.99	$6.73	$6.70	$6.80
Vitrified—					
Quantity	(a)	(a)	2,900,000	(a)	(a)
Value	(a)	(a)	$24,600	(a)	(a)
Average per M	$7.58	$8.00	$8.48	$7.59	$10.50
Front—					
Quantity	(a)	(a)	7,280,000	(a)	(a)
Value	(a)	(a)	$100,654	(a)	(a)
Average per M	$14.10	$13.96	$13.83	$13.99	$18.17
Fancy.....value	(a)	(a)	(a)	(a)	.....
Fire.....do	.....	(a)	.....	(a)	.....
Drain tile.....do	.....	(a)	(a)	$12,346	(a)
Fireproofing.....do	(a)	(a)	$29,000	$63,191	(a)
Miscellaneous.....do	$132,048	$155,006	$10,008	$104,833	$199,917
Total value	$1,006,743	$990,708	$953,432	$946,516	$1,146,449
Number of operating firms reporting	102	98	89	90	79
Rank of State	27	27	27	25	26

a Included in "Miscellaneous."

Clay products of the United States, by States, from 1905 to 1909—Continued.

NEW JERSEY.

Product.	1905.	1906.	1907.	1908.	1909.
Brick:					
Common—					
Quantity	465,040,000	413,258,000	388,735,000	300,544,000	460,966,000
Value	$3,090,809	$2,610,686	$2,289,883	$1,579,835	$2,609,605
Average per M	$6.65	$6.32	$5.89	$5.26	$5.66
Vitrified—					
Quantity	991,000	(a)	(a)	(a)	(a)
Value	$13,803	(a)	(a)	(a)	(a)
Average per M	$13.93	$14.98	$13.31	$11.43	$11.41
Front—					
Quantity	53,770,000	62,138,000	61,521,000	64,302,000	80,855,000
Value	$852,744	$896,887	$825,767	$667,682	$862,245
Average per M	$15.86	$14.43	$13.42	$10.38	$10.66
Fancy or ornamental . value	$1,975	$1,951	$4,605	$3,619	$8,578
Enameled . do	(a)	(a)	(a)	(a)	(a)
Fire . do	$1,393,448	$954,081	$947,472	$800,987	$907,276
Stove lining . do	(a)	(a)	(a)	(a)	....
Draintile . do	$24,315	$23,209	$21,869	$30,325	$37,211
Sewer pipe . do	$56,576	(a)	(a)	(a)	(a)
Architectural terra cotta . do	$1,614,263	$1,682,022	$1,722,067	$1,039,856	$1,637,705
Fireproofing, terra-cotta lumber, and hollow building tile or blocks . value	$1,308,075	$1,485,195	$1,159,467	$826,224	$1,299,540
Tile, not drain . do	$585,130	$1,163,401	$1,050,085	$835,499	$992,606
Pottery:					
Red earthenware . value	$19,650	$22,068	$21,067	$20,100	$36,573
Stoneware and yellow and Rockingham ware . value	$51,175	$54,725	(a)	(a)	$66,293
White ware, including C. C. ware, white granite semi-porcelain ware and semi-vitreous porcelain ware, value	$1,610,926	$1,436,246	$1,225,691	$1,137,701	$1,242,361
China, bone china, delft, and belleek ware . value	$945,917	$1,065,986	$1,135,885	$876,259	$1,082,398
Sanitary ware . do	$3,426,291	$3,742,045	$3,615,685	$3,182,772	$4,341,040
Porcelain electrical supplies, value	$540,206	$783,549	$744,068	$559,556	$823,056
Miscellaneous . value	$1,164,222	$1,440,218	$1,241,849	$753,281	$1,225,607
Total value	$16,699,525	$17,362,269	$16,005,460	$12,313,696	$17,172,094
Number of operating firms reporting	163	175	165	165	165
Rank of State	3	3	3	3	3

[a] Included in "Miscellaneous."

Clay products of the United States, by States, from 1905 to 1909—Continued.

NEW YORK.

Product.	1905.	1906.	1907-	1908-	1909-
Brick:					
Common—					
Quantity	1,518,196,000	1,535,579,000	1,319,416,000	1,055,006,000	1,542,552,000
Value	$10,297,214	$9,205,981	$7,056,453	$5,066,084	$7,760,746
Average per M	$6.78	$6.00	$5.35	$4.80	$5.03
Vitrified—					
Quantity	12,076,000	10,787,000	18,516,000	14,570,000	16,063,000
Value	$149,391	$163,969	$253,664	$211,290	$238,697
Average per M	$12.37	$15.20	$13.70	$14.50	$14.86
Front—					
Quantity	12,610,000	23,625,000	12,265,000	9,721,000	9,815,000
Value	$237,305	$351,824	$198,265	$135,342	$148,126
Average per M	$18.82	$14.89	$16.17	$13.92	$15.09
Fancy or ornamental. value	(a)	....	(a)	(a)	....
Enameled .... do	....	(a)	....	....	....
Fire .... do	$427,873	$451,783	$538,721	$436,847	$491,872
Stove lining .... do	$133,383	$131,908	$129,467	$102,985	$79,653
Draintile .... do	$153,598	$153,237	$180,818	$275,681	$125,640
Sewer pipe .... do	(a)	(a)	(a)	$133,716	$126,908
Architectural terra cotta ..do	$874,722	$967,987	$1,089,278	$709,360	$998,535
Fireproofing .... do	$128,872	$108,059	$120,318	$122,395	$199,999
Tile, not drain .... do	$164,445	$101,319	$43,726	$40,066	$62,795
Pottery:					
Earthenware .... value	$32,240	$34,034	$32,896	$31,645	$30,200
Stoneware and yellow and Rockingham ware..value	$51,540	$70,131	$87,471	$44,713	$46,905
White ware, including C. C. ware, white granite, semi-porcelain ware, and semi-vitreous porcelain ware, value	(a)	(a)	(a)	(a)	(a)
China, bone china, delft and belleek ware .... value	(a)	$657,817	$746,634	$622,548	$592,611
Sanitary ware .... do	(a)	(a)	(a)	(a)	(a)
Porcelain electrical supplies, value	$617,663	$663,886	$626,032	$560,754	$752,185
Miscellaneous .... do	$1,218,101	$814,672	$669,131	$435,798	$502,564
Total value	$14,486,347	$13,876,607	$11,772,874	$8,929,224	$12,157,436
Number of operating firms reporting	249	253	247	241	243
Rank of State	4	4	5	5	5

NORTH CAROLINA.

Product.	1905.	1906.	1907-	1908-	1909-
Brick:					
Common—					
Quantity	150,880,000	166,338,000	174,800,000	144,192,000	188,313,000
Value	$878,539	$1,041,078	$1,150,685	$900,611	$1,140,727
Average per M	$5.82	$6.26	$6.58	$6.25	$6.06
Vitrified—					
Quantity	(a)	(a)	(a)	(a)	....
Value	(a)	(a)	(a)	(a)	....
Average per M	$9.00	$10.00	$10.00	$8.00	....
Front—					
Quantity	755,000	385,000	770,000	300,000	725,000
Value	$12,725	$4,410	$7,925	$2,700	$9,250
Average per M	$16.85	$11.45	$10.29	$9.00	$12.76
Fancy .... value	(a)	....	....	....	....
Fire .... do	(a)	(a)	(a)	$7,560	....
Draintile .... do	$5,620	(a)	(a)	$1,635	$8,890
Sewer pipe .... do	(a)	(a)	(a)	(a)	(a)
Fireproofing .... do	....	(a)	....	(a)	....
Pottery:					
Red earthenware .... do	$387	$713	$2,382	$775	$1,780
Stoneware and yellow and Rockingham ware..value	$12,932	$11,057	$7,840	$12,587	$16,929
Miscellaneous .... do	$109,958	$125,080	$146,990	$18,100	$125,035
Total value	$1,020,161	$1,182,338	$1,315,822	$943,968	$1,302,611
Number of operating firms reporting	177	214	215	216	187
Rank of State	26	26	25	26	25

a Included in "Miscellaneous."

Clay products of the United States, by States, from 1905 to 1909—Continued.

OHIO.

Product.	1905.	1906.	1907.	1908.	1909.
Brick:					
Common—					
Quantity	514,419,000	550,422,000	495,025,000	369,410,000	420,999,000
Value	$3,033,435	$3,243,157	$3,012,485	$2,105,910	$2,429,879
Average per M	$5.90	$5.89	$6.09	$5.70	$5.77
Vitrified—					
Quantity	224,086,000	202,978,000	264,571,000	327,718,000	324,530,000
Value	$2,055,120	$1,955,360	$2,672,600	$3,232,335	$3,113,128
Average per M	$9.17	$9.63	$10.10	$9.86	$9.59
Front—					
Quantity	89,390,000	90,310,000	88,992,000	94,435,000	130,684,000
Value	$1,074,007	$1,025,590	$1,033,434	$1,067,888	$1,393,787
Average per M	$12.01	$11.36	$11.61	$11.31	$10.67
Fancy or ornamental . value	$18,153	$38,218	$24,468	$39,309	$24,367
Fire . do	$1,427,919	$1,670,630	$1,668,728	$1,339,810	$1,730,401
Stove lining . do	$49,538	$110,800	$22,416	(a)	$23,803
Draintile . do	$1,291,323	$1,520,748	$1,433,341	$1,725,462	$2,032,528
Sewer pipe . do	$3,550,160	$3,987,360	$3,792,352	$3,918,971	$3,009,798
Architectural terra cotta . do	...	(a)	(a)	...	(a)
Fireproofing, terra-cotta lumber, and hollow building tile or blocks . value	$923,762	$1,159,021	$1,006,076	$552,887	$804,637
Tile, not drain . do	$1,188,460	$1,523,410	$1,586,174	$1,438,042	$1,912,343
Pottery:					
Red earthenware . do	$137,705	$206,258	$142,042	$138,431	$145,137
Stoneware and yellow and Rockingham ware . value	$1,487,445	$1,581,732	$1,648,213	$1,468,197	$1,806,798
White ware, including C. C. ware, white granite, semi-porcelain ware, and semi-vitreous porcelain ware, value	$9,131,422	$9,735,072	$9,419,960	$7,228,636	$8,884,189
China, bone china, delft and belleek ware . value	(a)	(a)	(a)	(a)	(a)
Sanitary ware . do	(a)	$285,000	$226,000	$233,000	$310,254
Porcelain electrical supplies, value	$879,207	$1,100,979	$933,256	$719,034	$1,146,694
Miscellaneous . do	$2,055,383	$1,870,830	$1,719,285	$1,414,578	$1,578,498
Total value	$28,303,039	$31,014,165	$30,340,830	$26,622,490	$30,346,241
Number of operating firms reporting	792	784	736	706	685
Rank of State	1	1	1	1	1

OKLAHOMA.[b]

Product.	1905.	1906.	1907.	1908.	1909.
Brick:					
Common—					
Quantity	70,007,000	75,831,000	88,124,000	74,836,000	156,889,000
Value	$460,298	$486,770	$590,488	$457,588	$952,453
Average per M	$6.57	$6.42	$6.70	$6.11	$6.07
Vitrified—					
Quantity	1,950,000	2,269,000	4,528,000	7,681,000	7,186,000
Value	$15,500	$21,031	$39,676	$71,545	$58,388
Average per M	$7.95	$9.27	$8.76	$9.31	$8.13
Front—					
Quantity	2,852,000	1,292,000	1,752,000	1,231,000	1,796,000
Value	$25,020	$14,562	$20,990	$16,010	$21,473
Average per M	$8.77	$11.27	$11.98	$13.01	$11.96
Fancy or ornamental . value	...	(a)	...	(a)	...
Fire—					
Quantity	(a)	(a)	(a)	(a)	...
Value	(a)	(a)	(a)	(a)	...
Average per M	$12.00	$17.10	$15.53	$40.00	...
Drain tile . value	...	...	...	(a)	...
Miscellaneous . do	$95,481	$18,538	$13,358	$17,786	...
Total value	$596,299	$540,901	$664,512	$562,929	$1,032,314
Number of operating firms reporting	55	47	41	33	39
Rank of State	...	34	31	32	28

a Included in "Miscellaneous."

b Including Indian Territory in 1905 and 1906.

Clay products of the United States, by States, from 1905 to 1909—Continued.

PENNSYLVANIA.

Product.	1905.	1906.	1907.	1908.	1909.
Brick:					
Common—					
Quantity	1,036,777,000	1,027,541,000	980,102,000	717,016,000	872,658,000
Value	$6,532,814	$6,586,374	$6,353,799	$4,539,978	$5,607,490
Average per M	$6.30	$6.41	$6.48	$6.33	$6.43
Vitrified—					
Quantity	71,888,000	93,417,000	115,729,000	90,044,000	116,735,000
Value	$750,389	$996,347	$1,232,718	$1,038,254	$1,329,317
Average per M	$10.44	$10.67	$10.65	$11.53	$11.39
Front—					
Quantity	131,368,000	151,138,000	134,869,000	124,642,000	194,695,000
Value	$1,683,031	$1,761,991	$1,526,565	$1,403,594	$2,111,556
Average per M	$12.81	$11.66	$11.32	$11.26	$10.85
Fancy or ornamental. value	$37,966	$40,880	$17,727	$49,199	$27,963
Enameled do	(a)	(a)	(a)	(a)	(a)
Fire do	$5,771,795	$6,854,640	$6,907,904	$4,252,325	$8,107,807
Stove lining do	$180,353	$203,674	$179,218	$129,686	$97,270
Draintile do	$13,509	$9,113	$10,386	$14,904	$14,668
Sewer pipe do	$886,979	$985,635	$795,991	$578,800	$445,594
Architectural terra cotta do	$405,015	$367,353	$507,116	$389,596	$428,522
Fireproofing, terra-cotta lumber, hollow building tile or blocks value	$352,107	$242,668	$244,773	$241,175	$324,860
Tile, not drain do	$310,931	$389,013	$406,269	$337,948	$441,243
Pottery:					
Red earthenware do	$149,786	$165,073	$164,096	$138,181	$159,796
Stoneware and yellow and Rockingham ware value	$359,325	$312,150	$380,361	$259,095	$297,029
White ware, including C. C. ware, white granite ware, semiporcelain ware, and semivitreous porcelain ware value	$716,245	$845,366	$531,634	$623,544	$812,338
China, bone China, delft, and belleek ware value	(a)	(a)	(a)	$69,994	$91,757
Sanitary ware do	(a)	$186,560	$192,854	$175,384	$252,951
Porcelain electrical supplies, value	....	....	....	....	(a)
Miscellaneous value	$974,308	$1,827,774	$840,210	$601,325	$636,552
Total value	$19,124,553	$21,774,611	$20,291,621	$14,842,982	$21,186,713
Number of operating firms reporting	516	514	487	466	457
Rank of State	2	2	2	2	2

TENNESSEE.

Product.	1905.	1906.	1907.	1908.	1909.
Brick:					
Common—					
Quantity	173,379,000	169,371,000	170,972,000	134,171,000	159,328,000
Value	$1,028,653	$1,038,266	$1,036,112	$767,773	$1,022,282
Average per M	$5.93	$6.13	$6.06	$5.72	$6.42
Vitrified—					
Quantity	(a)	(a)	(a)	(a)	(a)
Value	(a)	(a)	(a)	(a)	(a)
Average per M	$11.50	$13.00	$11.98	$11.46	$13.08
Front—					
Quantity	9,983,000	12,077,000	15,514,000	9,494,000	11,397,000
Value	$103,650	$124,031	$169,616	$103,228	$125,661
Average per M	$10.38	$10.27	$10.93	$10.87	$11.03
Fancy value	$3,672	$3,663	$3,087	$1,505	(a)
Fire do	$35,300	$45,379	$40,959	$21,029	(a)
Draintile do	$23,116	$19,719	$28,000	$36,114	$67,472
Sewer pipe do	(a)	(a)	(a)	(a)	(a)
Architectural terra cotta do	(a)	....	....	....	....
Fireproofing do	....	(a)	(a)	(a)	(a)
Pottery:					
Red earthenware value	(a)	(a)	$6,185	(a)	(a)
Stoneware and yellow and Rockingham ware value	$115,580	$163,900	$111,030	$56,532	$35,100
Miscellaneous do	$183,308	$225,268	$218,873	$250,253	$398,357
Total value	$1,493,279	$1,620,226	$1,613,862	$1,236,434	$1,648,872
Number of operating firms reporting	121	116	116	104	100
Rank of State	22	22	22	23	23

a Included in "Miscellaneous."

Clay products of the United States, by States, from 1905 to 1909—Continued.

TEXAS.

Product.	1905.	1906.	1907.	1908.	1909.
Brick:					
Common—					
Quantity	202,070,000	211,842,000	243,853,000	194,551,000	293,660,000
Value	$1,209,898	$1,307,199	$1,707,812	$1,285,857	$1,890,601
Average per M	$5.99	$6.17	$7.00	$6.61	$6.44
Vitrified—					
Quantity	(a)	(a)	(a)	(a)	(a)
Value	(a)	(a)	(a)	(a)	(a)
Average per M	$10.47	$10.00	$10.36	$10.81	$10.32
Front—					
Quantity	8,001,000	8,492,000	11,494,000	10,411,000	26,726,000
Value	$102,054	$110,189	$153,187	$154,298	$407,023
Average per M	$12.76	$12.98	$13.33	$14.82	$15.23
Fancy or ornamental. value	$18,127	(a)	....	....	(a)
Fire do	$14,724	$45,557	$75,946	$69,039	$123,393
Draintile do	....	$3,652	(a)	$5,275	$28,414
Sewer pipe do	(a)	(a)	(a)	(a)	(a)
Fireproofing do	....	....	....	(a)	$20,170
Tile, not drain do	....	(a)	....	(a)	....
Pottery:					
Red earthenware do	$6,114	$10,045	$6,759	$10,267	$10,889
Stoneware and yellow and Rockingham ware value	$94,674	$98,590	$149,414	$114,879	$111,539
Miscellaneous do	$273,354	$394,366	$464,443	$427,120	$556,434
Total value	$1,718,945	$1,969,598	$2,557,561	$2,066,735	$3,148,463
Number of operating firms reporting	129	139	131	122	113
Rank of State	18	16	12	14	11

VIRGINIA.

Product.	1905.	1906.	1907.	1908.	1909.
Brick:					
Common—					
Quantity	237,161,000	232,697,000	197,052,000	185,738,000	249,794,000
Value	$1,572,442	$1,536,312	$1,285,374	$1,219,946	$1,540,648
Average per M	$6.63	$6.60	$6.52	$6.57	$6.17
Vitrified—					
Quantity	(a)	....	....	....	....
Value	(a)	....	....	....	....
Average per M	$10.80	....	....	....	....
Front—					
Quantity	22,155,000	25,385,000	19,989,000	17,858,000	24,717,000
Value	$352,297	$392,130	$290,411	$246,623	$333,057
Average per M	$15.90	$15.45	$14.53	$13.81	$13.47
Fancy or ornamental. value	$20,363	(a)	(a)	(a)	(a)
Fire do	(a)	$21,110	(a)	(a)	(a)
Draintile do	$4,500	$4,805	$6,250	$7,100	$6,298
Sewer pipe do	....	....	....	(a)	(a)
Porcelain electrical supplies, value	(b)	(b)	(b)	(b)	(a)
Miscellaneous value	$44,976	$11,721	$29,300	$25,461	$76,514
Total value	$1,994,578	$1,966,078	$1,611,335	$1,499,130	$1,956,517
Number of operating firms reporting	94	91	87	80	89
Rank of State	15	17	23	21	18

[a] Included in "Miscellaneous."

[b] The value of pottery products for Virginia for 1905, 1906, 1907, and 1908 could not be included in the State total without disclosing individual figures.

Clay products of the United States, from 1905 to 1909—Continued.

WASHINGTON.

Product.	1905.	1906.	1907.	1908.	1909.
Brick:					
Common—					
Quantity	81,022,000	99,788,000	101,905,000	107,638,000	143,198,000
Value	$566,385	$708,968	$846,971	$817,962	$1,081,579
Average per M	$6.99	$7.10	$8.31	$7.60	$7.55
Vitrified—					
Quantity	9,763,000	9,609,000	(a)	(a)	(a)
Value	$143,702	$156,476	(a)	(a)	(a)
Average per M	$14.72	$16.28	$18.22	$19.82	$18.72
Front—					
Quantity	3,304,000	4,439,000	4,539,000	4,011,000	7,802,000
Value	$86,388	$122,770	$127,245	$112,749	$155,600
Average per M	$26.15	$27.66	$28.03	$28.11	$19.94
Fancy ... value	$5,425	....	....	....	....
Fire ... do	$24,699	$46,525	$43,940	$42,045	$103,531
Draintile ... do	$11,153	$13,057	$17,025	$28,551	$18,495
Sewer pipe ... do	$242,245	$313,880	$482,870	$493,165	$737,847
Architectural terra cotta ... do	(a)	(a)	$94,795	$171,845	$206,324
Fireproofing ... do	(a)	$15,905	(a)	$45,205	$71,067
Tile, not drain ... do	....	(a)	....	....	....
Pottery:					
Red earthenware ... value	$6,300	$5,500	$2,500	$2,450	(a)
Stoneware and yellow and Rockingham ware ... value	$34,800	$36,060	$28,195	(a)	(a)
Miscellaneous ... do	$53,935	$80,743	$278,393	$390,317	$686,043
Total value	$1,175,032	$1,499,884	$1,921,934	$2,104,289	$3,060,486
Number of operating firms reporting	72	61	63	67	65
Rank of State	25	24	17	13	12

WEST VIRGINIA.

Product.	1905.	1906.	1907.	1908.	1909.
Brick:					
Common—					
Quantity	69,228,000	74,833,000	58,102,000	47,402,000	53,983,000
Value	$476,630	$469,527	$384,007	$300,776	$327,141
Average per M	$6.88	$6.27	$6.61	$6.35	$6.06
Vitrified—					
Quantity	24,692,000	47,902,000	60,681,000	70,924,000	45,661,000
Value	$263,449	$578,164	$952,060	$718,017	$565,218
Average per M	$10.67	$12.07	$15.69	$10.12	$12.38
Front—					
Quantity	(a)	(a)	(a)	(a)	(a)
Value	(a)	(a)	(a)	(a)	(a)
Average per M	$16.67	$15.00	$15.16	$14.18	$14.74
Fire ... value	$26,868	$59,757	$34,438	$38,943	$80,773
Draintile ... do	(a)	(a)	$1,211	$2,645	(a)
Sewer pipe ... do	(a)	(a)	....	(a)	(a)
Fireproofing ... do	....	....	(a)	(a)	(a)
Tile, not drain ... do	(a)	(a)	$52,429	$49,220	$82,461
Pottery:					
Stoneware and yellow and Rockingham ware ... value	$19,110	$23,200	(a)	(a)	(a)
White ware, including C. C. ware, white granite ware, semiporcelain ware, and semivitreous porcelain ware ... value	$814,195	$1,047,770	$1,651,732	$1,612,321	$1,769,808
Sanitary ware ... do	(a)	$387,000	$378,000	$385,000	$500,432
Porcelain electrical supplies, value	(a)	(a)	(a)	(a)	....
Miscellaneous ... value	$418,543	$217,894	$186,510	$154,814	$184,264
Total value	$2,018,795	$2,783,312	$3,640,387	$3,261,736	$3,510,097
Number of operating firms reporting	62	65	63	60	50
Rank of State	14	10	10	10	10

a Included in "Miscellaneous."

Clay products of the United States, from 1905 to 1909—Continued.

WISCONSIN.

Product.	1905.	1906.	1907.	1908.	1909.
Brick:					
Common—					
Quantity	186,531,000	170,496,000	158,602,000	129,041,000	147,741,000
Value	$1,260,066	$1,109,386	$1,019,522	$830,249	$956,232
Average per M	$6.76	$6.51	$6.43	$6.43	$6.47
Vitrified—					
Quantity			(a)		
Value			(a)		
Average per M			$8.04		
Front—					
Quantity	4,917,000	5,384,000	4,106,000	4,646,000	7,788,000
Value	$49,275	$52,038	$43,387	$41,569	$74,120
Average per M	$10.02	$9.67	$10.57	$8.95	$9.52
Fancy or ornamental.value	$1,048	(a)	(a)	(a)	(a)
Fire.....do					(a)
Draintile.....do	$57,576	$51,143	$49,832	$74,702	$95,899
Fireproofing.....do	(a)	$810	$1,595	(a)	(a)
Tile, not drain.....do				(a)	
Pottery:					
Earthenware.....do	$11,950	$11,470	$8,832	$9,300	$9,109
Stoneware.....do					(a)
Miscellaneous.....do	$2,200	$2,495	$4,651	$2,575	$4,229
Total value	$1,382,115	$1,227,342	$1,127,819	$958,395	$1,139,589
Number of operating firms reporting	157	147	138	121	106
Rank of State	24	25	26	24	27

a Included in "Miscellaneous."

BUILDING OPERATIONS.

The following tables show the building operations of some of the leading cities of the country.

Used as an index of prosperity, the figures here given show that the country in 1909 had recovered from the financial disturbance of 1907–8 and that the record of 1906 was surpassed.

An effort was made to get detailed information for 1909 from the leading 151 cities showing the building operations by character of the operation. For 128 cities sufficient detail was secured to include these cities in a table; for 9 cities only the totals for permits and cost of buildings could be obtained; and for 14 cities no data were furnished.

The first table shows a comparison between 1908 and 1909 in 51 cities. It also shows the increase or decrease in the cost of buildings erected in each of these 51 cities, the total increase in 1909, and the percentage of increase or decrease in each city.

The second table gives a statement of the building operations for 128 cities by character of operations.

Building operations in some of the leading cities of the United States in 1908 and 1909.

City.	1908.		1909.		Gain (+) or loss (—) in 1909.	Percentage of gain or loss in 1909.	Rank of cities in cost of buildings erected in 1909.
	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.			
Atlanta, Ga	4,153	$4,833,941	4,399	$5,551,951	+ $718,010	+ 14.85	32
Baltimore, Md	2,893	7,554,709	3,076	9,761,788	+ 2,207,079	+ 29.21	22
Boston, Mass	2,632	11,253,712	3,702	16,756,431	+ 5,502,719	+ 48.90	8
Brooklyn, N. Y	10,769	45,865,240	13,756	64,267,301	+ 18,402,061	+ 40.12	3
Buffalo, N. Y	2,788	6,847,000	3,361	9,895,000	+ 3,048,000	+ 44.52	21
Cambridge, Mass	425	2,153,070	490	2,249,745	+ 96,675	+ 4.49	69
Chicago, Ill	10,627	67,234,800	21,941	95,238,380	+ 28,003,580	+ 41.65	2
Cincinnati, Ohio	3,553	6,428,888	3,181	7,429,529	+ 1,000,641	+ 15.56	26
Cleveland, Ohio	6,674	9,896,869	6,834	13,028,294	+ 3,131,425	+ 31.64	17
Columbus, Ohio	1,698	3,400,273	1,790	3,598,601	+ 198,328	+ 5.83	48
Dayton, Ohio	1,193	3,234,280	794	1,700,500	— 1,533,780	— 47.42	82
Denver, Colo	3,117	10,098,020	3,270	11,554,983	+ 1,456,963	+ 14.43	20
Detroit, Mich	3,662	10,682,170	4,399	14,301,450	+ 3,619,280	+ 33.88	10
Fall River, Mass	399	1,140,927	461	1,146,702	+ 5,775	+ .51	99
Grand Rapids, Mich	1,064	2,181,759	1,290	2,872,427	+ 690,668	+ 31.66	58
Hartford, Conn	676	3,107,348	863	3,440,925	+ 333,577	+ 10.74	51
Indianapolis, Ind	4,013	5,895,928	3,931	7,156,560	+ 1,260,632	+ 21.38	28
Jersey City, N. J	1,367	4,490,466	1,466	6,882,610	+ 2,392,144	+ 53.27	29
Kansas City, Kans	792	1,108,472	728	1,196,390	+ 87,918	+ 7.93	97
Kansas City, Mo	3,840	10,562,041	4,194	13,367,730	+ 2,805,689	+ 26.56	14
Los Angeles, Cal	7,371	9,931,377	8,522	13,256,329	+ 3,324,952	+ 33.48	15
Louisville, Ky	2,909	2,914,141	2,823	2,972,505	+ 58,364	+ 2.00	55
Lowell, Mass	497	1,019,081	506	1,328,853	+ 309,772	+ 30.40	94
Memphis, Tenn	2,519	3,300,508	2,556	4,324,377	+ 1,023,869	+ 31.02	41
Milwaukee, Wis	4,169	10,065,669	5,068	11,841,713	+ 1,776,044	+ 17.64	19
Minneapolis, Minn	5,638	10,093,915	6,055	13,092,390	+ 2,998,475	+ 29.71	16
Nashville, Tenn	4,215	1,969,505	2,231	1,676,572	— 292,933	— 14.87	84
Newark, N. J	2,419	7,161,668	3,082	14,177,159	+ 7,015,491	+ 97.96	11
New Bedford, Mass	774	2,872,300	986	6,267,650	+ 3,395,350	+ 118.21	30
New Haven, Conn	919	3,091,465	1,047	4,226,322	+ 1,134,857	+ 36.71	43
New Orleans, La	2,457	5,744,311	2,795	5,165,212	— 579,099	— 10.08	36
New York, N. Y	6,103	117,819,382	7,629	186,047,477	+ 68,228,095	+ 57.91	1
Oakland, Cal	3,614	6,320,563	3,286	5,318,512	— 1,002,051	— 15.85	35
Omaha, Nebr	1,526	4,590,650	1,606	7,204,140	+ 2,613,490	+ 56.93	27
Philadelphia, Pa	13,363	28,152,265	17,294	42,881,370	+ 14,729,105	+ 52.32	4
Pittsburg, Pa	4,023	13,136,387	2,503	14,026,888	+ 890,501	+ 6.78	12
Portland, Oreg	4,849	10,505,151	4,739	13,481,380	+ 2,976,229	+ 28.33	13
Providence, R. I	1,386	4,034,000	1,788	5,340,500	+ 1,306,500	+ 32.39	34
Reading, Pa	571	497,700	458	1,046,900	+ 549,200	+ 110.35	104
Richmond, Va	1,330	3,169,431	1,378	3,574,812	+ 405,381	+ 12.79	49
Rochester, N. Y	1,302	4,975,317	3,122	9,272,132	+ 4,296,815	+ 86.36	23
St. Joseph, Mo	678	1,717,723	937	2,255,759	+ 538,036	+ 31.32	68
St. Louis, Mo	9,119	21,190,369	9,279	23,733,272	+ 2,542,903	+ 12.00	6
St. Paul, Minn	[a] 2,270	7,625,538	4,158	12,158,354	+ 4,532,816	+ 59.44	18
San Francisco, Cal	6,729	31,668,341	5,773	26,184,068	— 5,484,273	— 17.32	5
Scranton, Pa	892	2,366,405	975	3,987,943	+ 1,621,538	+ 68.52	44
Seattle, Wash	7,901	13,777,329	14,884	19,044,335	+ 5,267,006	+ 38.23	7
Syracuse, N. Y	1,291	3,317,195	1,573	4,855,811	+ 1,538,616	+ 46.38	37
Toledo, Ohio	1,065	2,081,448	1,314	2,014,462	— 66,986	— 3.22	75
Washington, D. C	5,258	10,800,096	9,935	15,468,635	+ 4,668,539	+ 43.23	9
Worcester, Mass	1,102	2,286,261	1,270	4,314,435	+ 2,028,174	+ 88.71	42
Total	174,594	566,165,404	213,498	771,937,564	+205,772,160	+ 36.34	....

[a] Estimated.

Of the 51 cities included in this table 45 showed increases in 1909 over 1908, and 6 showed decreases. The total of the increases was $214,731,282; of the decreases, $8,959,122—a net increase of $205,772,160, or 36.34 per cent. In 1908, 33 cities showed decreases aggregating $103,880,879, and 18 cities increases of $23,986,428, a net decrease of $79,894,451, or 12.37 per cent. For 1907 building operations costing $646,059,855 were reported, which would make the increase in 1909 over 1907, $125,877,709, or 19.48 per cent. Estimating the cost of the building operations in these cities in 1906, which was probably the year of greatest activity in the building trades up to that time, at $700,000,000—for 49 of these cities it was in that year

$678,710,969—the cost of building operations in 1909 was more than 10 per cent greater than that of 1906. This would indicate that in 1909 the building trades at least had recovered from the business depression of 1907–8.

The greatest increase reported for 1908 was $8,141,720, or 13.78 per cent, by Chicago, and the next largest $4,446,709, or 3.92 per cent, by New York. The increases in 1909 by these cities were $28,003,580, or 41.65 per cent, and $68,228,095, or 57.91 per cent, respectively. Brooklyn, which showed the largest decrease in 1908, showed the third largest gain in 1909—$18,402,061, or 40.12. New York City, including the boroughs of Manhattan and the Bronx, continued by far the leader in the cost of building, reporting $186,047,477 as the cost of its operations in 1909, which was nearly twice as much as the next largest city and over 24 per cent of the cost of all building operations of the 51 cities. If the cost of Brooklyn's buildings is added to that for New York, the total cost of the building operations of Greater New York in 1909 was $250,314,778, or nearly one-third of the cost of the operations in the 51 cities included in the table. Chicago was second in cost of building operations in 1909, reporting $95,238,380, which was a gain of $28,003,580, or 41.65 per cent; Brooklyn was third, and Philadelphia fourth.

Of the cities that showed decreases, San Francisco had the largest—$5,484,273, or 17.32 per cent—and Toledo the smallest—$66,986, or 3.22 per cent. The largest proportional decrease and the second largest actual decrease was that of Dayton, which was 47.42 per cent. Oakland was the third. The decreases in these cities may be ascribed to purely local causes. That of San Francisco is the most significant and indicates that the building activities of that city have probably reached a nearly normal condition after the abnormal condition following the great fire of 1906. Compared with the cost in 1905 ($18,268,753) the increase in the cost of building operations in 1909 in San Francisco was $7,915,315, or 43.33 per cent. The annual cost of building operations in that city since 1905 has been as follows: 1906, $34,927,396; 1907, $56,574,844; 1908, $31,668,341; and 1909, $26,184,068. Oakland's decrease was probably due to the same general conditions as the decrease of San Francisco.

The total number of permits issued increased from 174,594 in 1908 to 213,498 in 1909, a gain of 38,904, or 22.28 per cent. In 1908 there was a decrease of 12,851, or 6.86 per cent, in the number of permits issued. The number of permits ranged in 1909 from 458 in Reading to 21,941 in Chicago. The number of permits or buildings seems not to bear any definite relation to the cost of the operations, since several cities showing increases in cost of buildings showed decreases in the number of permits or buildings erected, while some of those showing decreases in cost showed increases in number of permits or buildings.

The average cost of operations under the total permits issued in these cities was $3,616 in 1909, and in 1908 it was $3,243. In New York the average cost was $24,387 in 1909, $19,305 in 1908, and $15,177 in 1907. In Chicago the average cost per operation was $4,341 in 1909 and $6,327 in 1908. In Brooklyn, the third largest city in cost of building operations, the average cost was $4,672 in 1909 and $4,259 in 1908. In Philadelphia the average was $2,480 per permit or building in 1909 and $2,107 in 1908. In San Francisco the average was $4,536 in 1909, $4,706 in 1908, $8,789 in 1907, and $3,371 in 1905.

These 51 cities report 82.96 per cent of the total cost of the building operations of the 137 cities given on another page. It is not possible to show comparisons for the whole 137 cities, as no figures were collected for the whole number for 1908.

The following table shows the building operations in the leading 137 cities of the country in 1909. For the first time an attempt was made to collect statistics of the building operations by character of buildings and also by additions, alterations, and repairs to each class of buildings. Figures for 128 cities are given in more or less detail, showing the kinds of buildings erected and the additions, alterations, and repairs to each class of buildings. For 9 cities it is possible to give only the totals for permits and for cost of all building operations.

Building statistics of the leading cities of the United States, by character of operations, in 1909.

City.	Wooden buildings.					
	New.		Additions, alterations, and repairs.		Total.	
	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.
Allentown, Pa	99	$39,600	15	$3,000	114	$42,600
Altoona, Pa	187	335,395	388	86,240	575	421,635
Atlanta, Ga	1,666	3,025,969	2,358	505,952	4,024	3,531,921
Atlantic City, N. J	145	595,342	238	461,400	383	1,056,742
Augusta, Ga	136	326,065	845	45,110	981	371,175
Baltimore, Md	129	541,529	(a)	(a)	129	541,529
Bayonne, N. J	322	1,251,389	125	98,018	447	1,349,407
Binghamton, N. Y	257	488,000	351	130,000	608	618,000
Birmingham, Ala	496	1,204,000	716	153,000	1,212	1,357,000
Boston, Mass	1,154	6,148,395	1,048	830,042	2,202	6,978,437
Bridgeport, Conn	500	1,583,278	260	400,000	760	1,983,278
Brockton, Mass	239	725,335	198	162,616	437	887,951
Brooklyn, N. Y	2,421	8,382,716	1,923	1,225,864	4,344	9,608,580
Buffalo, N. Y	1,924	4,691,245	1,165	813,175	3,089	5,504,420
Butte, Mont	92	161,890	73	46,990	165	208,880
Cambridge, Mass	190	919,822	197	141,300	387	1,061,122
Camden, N. J	61	122,000	327	81,800	388	203,800
Canton, Ohio	285	317,355	45	9,815	330	327,170
Charleston, S. C	96	180,665	70	41,032	166	221,697
Chattanooga, Tenn	298	502,215	1,882	128,901	2,180	631,116
Chelsea, Mass	196	882,690	116	61,535	312	944,225
Chester, Pa	13	7,000	....	....	13	7,000
Chicago, Ill	2,755	13,532,880	6,500	2,600,000	9,255	16,132,880
Cincinnati, Ohio	652	1,444,050	960	142,987	1,612	1,587,037
Cleveland, Ohio	2,906	4,206,005	2,509	501,107	5,415	4,707,112
Columbus, Ohio	590	540,602	446	445,000	1,036	985,602
Council Bluffs, Iowa	250	350,000	30	10,000	280	360,000
Dallas, Tex	1,010	1,540,077	495	237,301	1,505	1,777,378
Davenport, Iowa	123	269,920	....	....	123	269,920
Dayton, Ohio	570	714,200	103	53,460	673	767,660
Denver, Colo	141	112,825	30	3,265	171	116,090
Des Moines, Iowa	500	2,350,000	20	50,866	520	2,400,866
Detroit, Mich	3,108	5,500,000	625	500,000	3,733	6,000,000
Dubuque, Iowa	90	458,500	(b)	20,000	b 90	478,500
Duluth, Minn	640	1,045,363	476	192,520	1,116	1,237,883
East St. Louis, Ill	288	396,597	68	13,020	356	409,617
Elizabeth, N. J	397	1,227,413	80	61,770	477	1,289,183
Elmira, N. Y	118	247,000	64	44,800	182	291,800
Erie, Pa	311	524,766	304	197,937	615	722,703
Evansville, Ind	480	387,000	420	42,318	900	429,318
Fall River, Mass	279	642,747	117	84,855	396	727,602
Fitchburg, Mass	60	209,985	68	50,195	128	260,180

a Additions, alterations, and repairs to wooden buildings for Baltimore are included with those to brick buildings.
b No permits were issued for additions, etc., in Dubuque.

Building statistics of the leading cities of the United States, by character of operations, in 1909—Continued.

City.	Wooden buildings.					
	New.		Additions, alterations, and repairs.		Total.	
	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.
Fort Wayne, Ind	267	$620,000	104	$65,000	371	$685,000
Galveston, Tex	99	96,957	126	28,262	225	125,219
Grand Rapids, Mich	728	1,180,946	379	158,779	1,107	1,339,725
Harrisburg, Pa	30	76,775	47	18,275	77	95.050
Hartford, Conn	244	1,407,700	108	68,220	352	1,475,920
Haverhill, Mass	102	289,450	38	54,012	140	343,462
Hoboken, N. J	5	13,000	14	17,200	19	30,200
Holyoke, Mass	75	328,500	5	7,750	80	336,250
Houston, Tex	719	946,174	750	256,663	1,469	1,202,837
Indianapolis, Ind	1,667	2,987,978	1,512	503,518	3,179	3,491,496
Jacksonville, Fla	970	1,453,131	964	50,000	1,934	1,503,131
Jersey City, N. J	614	2,311,043	350	573,494	964	2,884,537
Kansas City, Kans	414	508,230	160	413,950	574	922,180
Kansas City, Mo	1,720	5,893,550	1,232	821,394	2,952	6,714,944
Knoxville, Tenn	185	297,802	500	31,050	685	328,852
Lancaster, Pa	....	....	20	2,000	20	2,000
Lawrence, Mass	377	1,634,090	73	107,110	450	1,741,200
Lincoln, Nebr	473	981,246	123	128,885	596	1,110,131
Los Angeles, Cal	5,284	8,205,837	2,453	688,642	7,737	8,894,479
Louisville, Ky	746	1,036,645	1,384	202,843	2,130	1,239,488
Lowell, Mass	222	459,590	217	120,884	439	580,474
Lynn, Mass	435	1,555,483	329	226,600	764	1,782,083
Macon, Ga	164	398,524	152	107,008	316	505,532
Malden, Mass	160	400,000	96	101,308	256	501,308
Manchester, N. H	213	611,400	215	171,938	428	783,338
Memphis, Tenn	852	1,196,278	1,041	279,089	1,893	1,475,367
Milwaukee, Wis	1,602	4,929,983	2,385	1,359,255	3,987	6,289,238
Minneapolis, Minn	3,369	8,015,770	2,628	1,686,720	5,997	9,702,490
Mobile, Ala	212	289,632	99	34,750	311	324,382
Montgomery, Ala	117	214,261	258	42,657	375	256,918
Nashville, Tenn	612	525,377	1,258	98,081	1,870	623,458
Newark, N. J	1,727	5,574,493	576	619,388	2,303	6,193,881
New Bedford, Mass	725	2,440,650	186	169,400	911	2,610,050
Newcastle, Pa	30	100,000	....	....	30	100,000
New Haven, Conn	488	1,755,271	301	128,968	789	1,884,239
Newton, Mass	166	550,430	84	82,360	250	632,790
New York, N. Y	823	3,697,555	461	431,585	1,284	4,129,140
Norfolk, Va	311	626,900	87	36,585	398	663,485
Oakland, Cal	1,665	3,502,316	1,572	556,505	3,237	4,058,821
Omaha, Nebr	1,108	2,809,215	221	40,100	1,329	2,849,315
Passaic, N. J	230	866,917	74	44,070	304	910,987
Paterson, N. J	355	1,028,496	329	134,463	684	1,162,959
Pawtucket, R. I	160	469,000	139	48,559	299	517,559
Peoria, Ill	340	849,703	160	73,222	500	922,925
Philadelphia, Pa	24	38,000	771	272,600	795	310,600
Pittsburg, Pa	1,159	5,795,000	261	427,201	1,420	6,222,201
Portland, Oreg	3,104	6,553,185	833	466,880	3,937	7,020,065
Providence, R. I	776	2,668,750	864	1,229,650	1,640	3,898,400
Quincy, Ill	30	62,700	10	20,000	40	82,700
Richmond, Va	371	377,834	235	71,561	606	449,395
Rochester, N. Y	2,074	5,705,378	740	591,373	2,814	6,296,751
Rockford, Ill	227	410,000	925	100,000	1,152	510,000
Sacramento, Cal	429	1,266,751	26	6,565	455	1,273,316
Saginaw, Mich	148	129,015	49	16,815	197	145,830
St. Louis, Mo	3,987	1,177,194	906	133,149	4,893	1,310,343
St. Paul, Minn	3,086	5,492,344	621	302,532	3,707	5,794,876
Salem, Mass	161	480,232	86	96,826	247	577,058
Salt Lake City, Utah	164	260,500	61	27,900	225	288,400
San Antonio, Tex	2,339	1,857,725	937	129,734	3,276	1,987,459
San Francisco, Cal	2,928	12,257,683	2,191	801,398	5,119	13,059,081
Schenectady, N. Y	405	882,450	203	77,217	608	959,667
Scranton, Pa	576	1,401,523	290	175,425	866	1,576,948
Seattle, Wash	7,355	9,843,805	4,735	1,255,254	12,090	11,099,059
Somerville, Mass	250	1,217,929	106	31,800	356	1,249,729
South Omaha, Nebr	200	224,000	14	2,850	214	226,850
Springfield, Ill	335	648,785	191	161,070	526	809,855
Springfield, Mass	307	800,000	319	450,000	626	1,250,000
Superior, Wis	140	338,885	....	....	140	338,885
Syracuse, N. Y	876	2,660,220	531	307,930	1,407	2,968,150
Tacoma, Wash	1,426	2,196,323	969	369,085	2,395	2,565,408
Taunton, Mass	33	486,000	1	6,000	34	492,000

Building statistics of the leading cities of the United States, by character of operations, in 1908—Continued.

City.	Wooden buildings.					
	New.		Additions, alterations, and repairs.		Total.	
	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.
Terre Haute, Ind	398	$509,275	252	$87,230	650	$596,505
Toledo, Ohio	953	332,400	131	108,395	1,084	440,795
Topeka, Kans	479	583,759	120	24,000	599	607,759
Trenton, N. J	270	184,354	188	116,445	458	300,799
Troy, N. Y	66	209,650	143	78,950	209	288,600
Washington, D. C	1,070	3,027,353	1,518	160,277	2,588	3,187,630
Wheeling, W. Va	48	124,864	166	75,229	214	200,093
Wichita, Kans	1,019	2,010,700	150	48,060	1,169	2,058,760
Wilkesbarre, Pa	364	725,191	150	169,661	514	894,852
Wilmington, Del	8	8,983	15	9,408	23	18,391
Worcester, Mass	638	2,188,795	467	197,720	1,105	2,386,515
Yonkers, N. Y	163	657,000	81	24,800	244	681,800
York, Pa	48	76,000	23	2,300	71	78,300
Youngstown, Ohio	780	1,154,961	131	60,590	911	1,215,551
Total	96,193	218,293,619	69,275	30,161,613	165,468	248,455,232
Per cent of total	....	24.16	....	3.34	....	27.50

City.	Fire-resisting buildings.							
	Brick.				Stone.			
	New.		Additions, alterations, and repairs.		New.		Additions, alterations, and repairs.	
	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.
Allentown, Pa	215	$1,717,840	70	$7,000	......	......	......	......
Altoona, Pa	19	133,100	13	18,510	2	$9,125	......	......
Atlanta, Ga	114	1,389,400	259	410,630	......	......	......	......
Atlantic City, N. J	275	1,047,025	64	230,600	......	......	2	$38,000
Augusta, Ga	21	344,973	150	21,500	......	......	......	......
Baltimore, Md	2,447	8,712,392	[a] 500	[a] 507,867	......	......	......	......
Bayonne, N. J	25	650,000	......	......	......	......	......	......
Binghamton, N. Y	21	87,415	1	18,700	......	......	......	......
Birmingham, Ala	46	912,700	242	72,005	......	......	......	......
Boston, Mass	390	7,285,550	1,103	2,471,344	......	......	......	......
Bridgeport, Conn	100	800,000	25	120,000	......	......	......	......
Brockton, Mass	4	185,000	5	18,100	......	......	......	......
Brooklyn, N. Y	[b] 7,884	[b] 51,747,760	[b] 1,528	[b] 2,910,961	([b])	([b])	([b])	([b])
Buffalo, N. Y	185	2,119,200	56	359,230	6	158,000	......	......
Butte, Mont	19	98,800	19	56,253	......	......	......	......
Cambridge, Mass	73	769,373	25	157,750	......	......	......	......
Camden, N. J	171	906,000	80	224,000	4	15,000	......	......
Canton, Ohio	34	104,975	......	......	......	......	......	......
Charleston, S. C	8	390,840	27	61,958	......	......	......	......
Chattanooga, Tenn	128	229,331	476	255,579	......	......	......	......
Chelsea, Mass	72	1,104,677	24	14,541	3	135,733	......	......
Chester, Pa	151	260,000	29	45,000	......	......	......	......
Chicago, Ill	5,960	51,145,400	3,000	1,500,000	2,007	15,985,300	1,000	500,000
Cincinnati, Ohio	816	5,413,630	728	374,964	......	......	......	......

[a] Additions, alterations, and repairs to wooden buildings for Baltimore are included with those to brick buildings.

[b] All classes of new fire-resisting buildings for Brooklyn, Minneapolis, and St. Louis are included with new brick buildings, and additions to all classes of fire-resisting buildings are included with brick additions for each of these cities.

Building statistics of the leading cities of the United States, by character of operations, in 1909—Continued.

City.	Fire-resisting buildings.							
	Brick.				Stone.			
	New.		Additions, alterations, and repairs.		New.		Additions, alterations, and repairs.	
	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.
Cleveland, Ohio	772	$7,164,961	328	$649,860	......	......	72	$14,518
Columbus, Ohio	464	995,860	268	441,738	2	$350,000	......	......
Council Bluffs, Iowa	25	250,000	20	40,000	......	......	1	75,000
Dallas, Tex	127	1,515,202	59	101,103	......	......	......	......
Davenport, Iowa	26	266,900	12	23,800	......	......	1	46,640
Dayton, Ohio	76	451,440	25	44,580	......	......	......	......
Denver, Colo	2,507	9,018,593	440	595,600	......	......	......	......
Des Moines, Iowa	148	1,075,000	6	350,000	2	25,000	......	......
Detroit, Mich	*a* 482	*a* 5,300,000	*a* 115	*a* 1,000,000	(*a*)	(*a*)	(*a*)	(*a*)
Dubuque, Iowa	79	451,000	(*b*)	120,000	1	7,500	......	......
Duluth, Minn	100	1,080,870	95	152,474	......	......	......	......
East St. Louis, Ill	109	435,562	4	17,000	......	......	......	......
Elizabeth, N. J	48	554,628	22	37,484	......	......	......	......
Elmira, N. Y	12	185,000	......	......	......	......	......	......
Erie, Pa	56	518,265	29	112,690	......	......	......	......
Evansville, Ind	37	248,000	60	12,610	1	10,000	......	......
Fall River, Mass	22	285,200	14	33,475	3	72,200	......	......
Fitchburg, Mass	47	438,050	......	......	......	......	......	......
Fort Wayne, Ind	30	530,950	24	47,075	......	......	......	......
Galveston, Tex	3	10,800	11	54,000	......	......	......	......
Grand Rapids, Mich	74	1,320,832	59	115,220	......	......	......	......
Harrisburg, Pa	583	1,864,675	89	75,725	3	25,600	......	......
Hartford, Conn	128	1,168,650	378	274,355	......	......	......	......
Haverhill, Mass	8	169,500	13	38,900	......	......	1	15,000
Hoboken, N. J	33	774,000	20	48,500	......	......	......	......
Holyoke, Mass	39	1,675,000	18	24,800	1	150,000	......	......
Houston, Tex	40	848,296	11	120,600	......	......	......	......
Indianapolis, Ind	347	3,411,475	376	125,879	......	......	......	......
Jacksonville, Fla	80	391,594	......	......	......	......	......	......
Jersey City, N. J	351	3,341,196	117	191,164	......	......	......	......
Kansas City, Kans	102	86,340	......	......	40	74,000	......	......
Kansas City, Mo	503	6,159,950	739	492,836	......	......	......	......
Knoxville, Tenn	49	436,402	201	32,730	......	......	......	......
Lancaster, Pa	429	1,004,289	523	104,600	......	......	......	......
Lawrence, Mass	15	2,641,250	19	111,750	......	......	......	......
Lincoln, Nebr	48	388,010	14	66,800	7	56,000	1	2,000
Los Angeles, Cal	255	2,562,789	507	609,313	......	......	......	......
Louisville, Ky	179	667,179	499	406,838	......	......	......	......
Lowell, Mass	16	438,254	50	160,125	......	......	......	......
Lynn, Mass	15	754,992	11	183,400	1	68,000	......	......
Macon, Ga	17	145,865	......	......	......	......	......	......
Malden, Mass	18	190,000	12	60,000	......	......	7	27,000
Manchester, N. H	11	916,850	22	79,330	......	......	......	......
Memphis, Tenn	167	958,425	375	150,000	98	988,308	......	......
Milwaukee, Wis	216	3,824,543	715	407,777	2	50,000	......	......
Minneapolis, Minn	*c* 43	*c* 2,776,400	*c* 15	*c* 613,500	(*c*)	(*c*)	(*c*)	(*c*)
Mobile, Ala	24	165,962	39	35,870	......	......	......	......
Montgomery, Ala	14	321,469	73	19,008	1	6,000	......	......
Nashville, Tenn	136	800,352	210	167,812	......	......	......	......
Newark, N. J	473	4,009,211	158	445,467	1	5,000	......	......
New Bedford, Mass	35	2,754,300	40	903,300	......	......	......	......
Newcastle, Pa	10	50,000	......	......	1	15,000	......	......
New Haven, Conn	134	1,152,783	118	182,000	3	807,000	......	......
Newton, Mass	4	287,000	......	......	......	......	......	......
New York, N. Y	2,514	151,832,438	3,648	11,214,059	31	3,462,000	61	1,023,200
Norfolk, Va	290	1,333,532	85	99,071	4	245,000	......	......
Oakland, Cal	19	462,846	11	215,509	......	......	......	......

a New stone buildings for Detroit are included with new brick buildings, and additions, etc., to stone buildings are included with additions to brick buildings.

b No permits were issued for additions, etc., in Dubuque.

c All classes of new fire-resisting buildings for Brooklyn, Minneapolis, and St. Louis are included with new brick buildings, and additions to all classes of fire-resisting buildings are included with brick additions for each of these cities.

Building statistics of the leading cities of the United States, by character of operations, in 1909—Continued.

City.	Fire-resisting buildings.							
	Brick.				Stone.			
	New.		Additions, alterations, and repairs.		New.		Additions, alterations, and repairs.	
	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.
Omaha, Nebr	227	$4,107,635	50	$247,190	....	....	....	....
Passaic, N. J	60	1,007,540	44	348,100	....	....	....	....
Paterson, N. J	97	1,091,746	27	44,605	....	....	....	....
Pawtucket, R. I	13	707,400	6	21,000	....	....	....	....
Peoria, Ill	47	484,758	48	115,948	....	....	....	....
Philadelphia, Pa	10,370	30,653,580	4,993	9,053,315	8	$120,000	167	$74,620
Pittsburg, Pa	854	7,051,987	166	282,200	32	292,000	3	10,500
Portland, Oreg	115	3,201,725	620	274,945	3	150,000	....	....
Providence, R. I	81	1,388,500	67	53,600	....	....	....	....
Quincy, Ill	31	331,700	15	30,000	1	4,000	....	....
Reading, Pa	259	631,900	65	77,500	52	205,000	14	30,000
Richmond, Va	474	2,570,060	297	505,357	1	50,000	....	....
Rochester, N. Y	126	1,503,173	63	164,595	6	158,007	1	25,000
Rockford, Ill	34	125,000	26	7,000	....	....	8	15,000
Sacramento, Cal	14	199,304	40	123,875	1	45,000	....	....
Saginaw, Mich	26	150,900	17	24,187	....	....	....	....
St. Louis, Mo	a2,764	a20,694,149	a1,622	a1,728,780	(a)	(a)	(a)	(a)
St. Paul, Minn	205	4,312,565	156	568,011	2	1,978	3	155,616
Salem, Mass	7	105,000	1	5,000	....	....	....	....
Salt Lake City, Utah	879	7,417,700	184	371,720	....	....	....	....
San Antonio, Tex	68	637,268	32	72,936	....	....	31	72,935
San Francisco, Cal	293	9,066,307	b330	b686,838	21	3,130,802	(b)	(b)
Schenectady, N. Y	40	801,012	32	115,566	....	....	....	....
Scranton, Pa	66	2,209,670	43	201,325	....	....	....	....
Seattle, Wash	105	3,791,680	1,865	572,811	....	....	....	....
Somerville, Mass	14	94,000	....	....	....	....	....	....
South Omaha, Nebr	8	56,000	....	....	9	1,900	....	....
Springfield, Ill	65	508,650	47	67,005	....	....	....	....
Springfield, Mass	393	4,000,000	186	375,000	....	....	7	20,000
Superior, Wis	16	394,014	....	....	....	....	....	....
Syracuse, N. Y	c76	c1,459,410	b90	b428,251	(c)	(c)	(b)	(b)
Tacoma, Wash	15	904,800	....	....	....	....	....	....
Taunton, Mass	9	233,000	1	10,000	....	....	....	....
Terre Haute, Ind	47	241,815	46	48,865	3	2,600	1	100
Toledo, Ohio	79	632,173	31	168,395	1	250,000	....	....
Topeka, Kans	20	120,562	7	39,350	5	192,300	8	36,000
Trenton, N. J	597	1,575,808	216	449,759	1	13,000	....	....
Troy, N. Y	53	700,100	96	113,625	....	....	....	....
Washington, D. C	1,358	10,303,372	5,883	1,293,433	10	30,000	25	12,000
Wheeling, W. Va	33	629,422	82	72,496	....	....	....	....
Wichita, Kans	60	1,536,400	2	11,500	5	16,500	15	6,500
Wilkesbarre, Pa	121	1,140,642	7	47,340	1	22,000	....	....
Wilmington, Del	401	1,099,002	296	344,742	10	100,800	....	....
Worcester, Mass	56	846,700	91	487,420	2	500,800	6	4,300
Yonkers, N. Y	135	1,739,350	32	33,700	....	....	....	....
York, Pa	275	550,000	300	50,000	....	....	....	....
Youngstown, Ohio	105	854,840	65	30,295	....	....	....	....
Total	52,958	504,280,630	37,408	51,233,799	2,398	28,006,453	1,435	2,203,929
Per cent of total	....	55.82	....	5.67	....	3.10	....	.25

a All classes of new fire-resisting buildings for Brooklyn, Minneapolis, and St. Louis are included with new brick buildings, and additions to all classes of fire-resisting buildings are included with brick additions for each of these cities.
b Additions, etc., to stone and concrete buildings for San Francisco and Syracuse are included with additions to brick buildings.
c New stone and new concrete buildings for Syracuse are included with new brick buildings.

Building statistics of the leading cities of the United States, by character of operations, in 1909—Continued.

City.	Fire-resisting buildings—Continued.							
	Concrete.				All other.			
	New.		Additions, alterations, and repairs.		New.		Additions, alterations, and repairs.	
	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.
Allentown, Pa	1	$65,000						
Altoona, Pa	2	11,125						
Atlanta, Ga	2	220,000						
Atlantic City, N. J	1	9,000						
Binghamton, N. Y	22	30,044						
Boston, Mass			1	$100			6	$21,000
Bridgeport, Conn	14	63,279						
Brooklyn, N. Y	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Buffalo, N. Y	10	430,200			15	$1,323,950		
Butte, Mont					5	137,287		
Cambridge, Mass	5	261,500						
Camden, N. J	3	301,900						
Canton, Ohio	5	5,950						
Charleston, S. C	16	8,000						
Chattanooga, Tenn					38	755		
Chelsea, Mass	5	5,900						
Chicago, Ill	519	9,894,800	200	80,000				
Cincinnati, Ohio	10	42,868					15	11,030
Cleveland, Ohio	140	448,660			11	24,632	96	18,551
Columbus, Ohio	3	700,000			17	125,401		
Davenport, Iowa			2	52,500				
Dayton, Ohio	20	436,820						
Denver, Colo	39	260,300	10	4,400	103	1,560,000		
Des Moines, Iowa	3	200,000			4	300,000	10	25,000
Detroit, Mich	21	1,300,000	11	100,000	35	551,245	2	50,205
Dubuque, Iowa	21	50,000						
Duluth, Minn					10	1,209,000		
East St. Louis, Ill					6	586,500		
Elizabeth, N. J	7	10,778	6	2,460			4	11,005
Elmira, N. Y	23	86,000						
Erie, Pa	13	18,605			4	4,570		
Evansville, Ind	2	53,765						
Fall River, Mass					9	12,590	17	15,635
Fort Wayne, Ind	23	150,000						
Galveston, Tex	1	10,000						
Grand Rapids, Mich	43	89,450	7	7,200				
Harrisburg, Pa	3	59,575			1	200		
Hartford, Conn					5	522,000		
Hoboken, N. J	2	250,000			2	1,600,000		
Holyoke, Mass	5	315,000			10	580,000		
Houston, Tex					17	2,154,000		
Indianapolis, Ind	29	127,710						
Jacksonville, Fla	8	465,300						
Jersey City, N. J	8	211,402	1	56,000	25	198,311		
Kansas City, Kans	12	113,870						
Lawrence, Mass	4	18,300						
Lincoln, Nebr	b 7	16,500	(b)	1,350	19	55,400		
Los Angeles, Cal	16	861,050	1	163,000	6	165,698		
Louisville, Ky					15	659,000		
Lowell, Mass	1	150,000						
Lynn, Mass	4	28,000	4	77,400				
Manchester, N. H					2	18,000		
Memphis, Tenn	11	30,700					12	721,577
Milwaukee, Wis	69	1,224,847	79	45,308				
Minneapolis, Minn	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Montgomery, Ala					2	8,450		
Nashville, Tenn	15	84,950						
Newark, N. J	82	200,600			65	3,323,000		

[a] All classes of new fire-resisting buildings for Brooklyn, Minneapolis, and St. Louis are included with new brick buildings, and additions to all classes of fire-resisting buildings are included with brick additions for each of these cities.

[b] The number of permits for additions, etc., to concrete buildings for Lincoln are included with the number for new concrete buildings.

Building statistics of the leading cities of the United States, by character of operations, in 1909—Continued.

City.	Fire-resisting buildings—Continued.							
	Concrete.				All other.			
	New.		Additions, alterations, and repairs.		New.		Additions, alterations, and repairs.	
	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.
New Haven, Conn	3	$200,300						
Newton, Mass	14	83,125			4	$2,825		
New York, N. Y	4	140,000	1	$1,000	25	12,863,100	61	$1,382,540
Norfolk, Va	2	34,000	2	61,500			26	20,365
Oakland, Cal	10	224,432			9	356,904		
Passaic, N. J	11	34,100						
Paterson, N. J	34	254,900						
Peoria, Ill	9	17,860			3	5,675		
Philadelphia, Pa	28	2,014,300	73	285,700			860	369,255
Pittsburg, Pa	24	144,000	4	24,000				
Portland, Oreg	56	1,231,520	3	2,100	3	1,600,000	2	1,025
Quincy, Ill	1	10,000						
Reading, Pa	47	75,000	10	14,000			11	13,500
Rochester, N. Y	84	133,560	3	2,500	25	988,546		
Rockford, Ill	5	160,000	3	2,000				
Sacramento, Cal	4	248,000			1	173,900		
Saginaw, Mich	5	10,700						
St. Louis, Mo	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
St. Paul, Minn	73	1,319,901	5	1,714			7	3,693
San Antonio, Tex	5	333,000			1	350,000		
San Francisco, Cal	10	241,040	(b)	(b)				
Schenectady, N. Y	6	18,400			3	4,800		
Seattle, Wash	32	2,872,400	540	104,283	2	550,000	250	54,102
Somerville, Mass	3	100,000						
Superior, Wis	2	3,000						
Syracuse, N. Y	(c)	(c)	(b)	(b)				
Tacoma, Wash					24	2,012,000		
Terre Haute, Ind	15	18,325	1	50				
Toledo, Ohio	2	425,647					117	97,452
Topeka, Kans	16	505,745	3	9,500	1	575		
Trenton, N. J	5	11,000						
Troy, N. Y	5	85,000						
Washington, D. C	6	20,200	20	10,000	15	600,000	30	12,000
Wheeling, W. Va	1	28,000	11	3,529				
Wilkesbarre, Pa	3	16,400						
Wilmington, Del	9	197,765						
Worcester, Mass	6	82,700	4	6,000				
Yonkers, N. Y			5	8,000				
York, Pa	1	8,000						
Total	1,791	30,624,068	1,010	1,125,594	542	34,628,314	1,526	2,827,935
Per cent of total		3.39		.13		3.83		.31

a All classes of new fire-resisting buildings for Brooklyn, Minneapolis, and St. Louis are included with new brick buildings, and additions to all classes of fire-resisting buildings are included with brick additions for each of these cities.

b Additions, etc., to stone and concrete buildings or San Francisco and Syracuse are included with additions to brick buildings.

c New stone and new concrete buildings for Syracuse are included with new brick buildings.

Building statistics of the leading cities of the United States, by character of operations, in 1909—Continued.

City.	Fire-resisting buildings—Continued. Total.		Grand total.		Rank of cities in cost of buildings erected in 1909.
	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	
Allentown, Pa	286	$1,789,840	400	$1,832,440	79
Altoona, Pa	36	171,860	611	593,495	125
Atlanta, Ga	375	2,020,030	4,399	5,551,951	32
Atlantic City, N. J	342	1,324,625	725	2,381,367	63
Augusta, Ga	171	366,473	1,152	737,648	113
Baltimore, Md	2,947	9,220,259	3,076	9,761,788	22
Bayonne, N. J	25	650,000	472	1,999,407	76
Binghamton, N. Y	44	136,159	652	754,159	111
Birmingham, Ala	288	984,705	1,500	2,341,705	66
Boston, Mass	1,500	9,777,994	3,702	16,756,431	8
Bridgeport, Conn	139	983,279	899	2,966,557	56
Brockton, Mass	9	203,100	446	1,091,051	103
Brooklyn, N. Y	9,412	54,658,721	13,756	64,267,301	3
Buffalo, N. Y	272	4,390,580	3,361	9,895,000	21
Butte, Mont	43	292,340	208	501,220	130
Cambridge, Mass	103	1,188,623	490	2,249,745	69
Camden, N. J	258	1,446,900	646	1,650,700	85
Canton, Ohio	39	110,925	369	438,095	132
Charleston, S. C	51	460,798	217	682,495	121
Chattanooga, Tenn	642	485,665	2,822	1,116,781	100
Chelsea, Mass	104	1,260,851	416	2,205,076	70
Chester, Pa	180	305,000	193	312,000	134
Chicago, Ill	12,686	79,105,500	21,941	95,238,380	2
Cincinnati, Ohio	1,569	5,842,492	3,181	7,429,529	26
Cleveland, Ohio	1,419	8,321,182	6,834	13,028,294	17
Columbus, Ohio	754	2,612,999	1,790	3,598,601	48
Council Bluffs, Iowa	46	365,000	326	725,000	116
Dallas, Tex	186	1,616,305	1,691	3,393,683	52
Davenport, Iowa	41	389,840	164	659,760	122
Dayton, Ohio	121	932,840	794	1,700,500	82
Denver, Colo	3,099	11,438,893	3,270	11,554,983	20
Des Moines, Iowa	173	1,975,000	693	4,375,866	39
Detroit, Mich	666	8,301,450	4,399	14,301,450	10
Dubuque, Iowa	[a] 101	628,500	[a] 191	1,107,000	102
Duluth, Minn	205	2,442,344	1,321	3,680,227	46
East St. Louis, Ill	119	1,039,062	475	1,448,679	89
Elizabeth, N. J	87	616,355	564	1,905,538	77
Elmira, N. Y	35	271,000	217	562,800	127
Erie, Pa	102	654,130	717	1,376,833	93
Evansville, Ind	100	324,375	1,000	753,693	112
Fall River, Mass	65	419,100	461	1,146,702	99
Fitchburg, Mass	47	438,050	175	698,230	118
Fort Wayne, Ind	77	728,025	448	1,413,025	91
Galveston, Tex	15	74,800	240	200,019	136
Grand Rapids, Mich	183	1,532,702	1,290	2,872,427	58
Harrisburg, Pa	679	2,025,775	756	2,120,825	72
Hartford, Conn	511	1,965,005	863	3,440,925	51
Haverhill, Mass	22	223,400	162	566,862	126
Hoboken, N. J	57	2,672,500	76	2,702,700	59
Holyoke, Mass	73	2,744,800	153	3,081,050	53
Houston, Tex	68	3,122,896	1,537	4,325,733	40
Indianapolis, Ind	752	3,665,064	3,931	7,156,560	28
Jacksonville, Fla	88	856,894	2,022	2,360,025	64
Jersey City, N. J	502	3,998,073	1,466	6,882,610	29
Kansas City, Kans	154	274,210	728	1,196,390	97
Kansas City, Mo	1,242	6,652,786	4,194	13,367,730	14
Knoxville, Tenn	250	469,132	935	797,984	109
Lancaster, Pa	952	1,108,889	972	1,110,889	101
Lawrence, Mass	38	2,771,300	488	4,512,500	38
Lincoln, Nebr	96	586,060	692	1,696,191	83
Los Angeles, Cal	785	4,361,850	8,522	13,256,329	15
Louisville, Ky	693	1,733,017	2,823	2,972,505	55
Lowell, Mass	67	748,379	506	1,328,853	94
Lynn, Mass	35	1,111,792	799	2,893,875	57
Macon, Ga	17	145,865	333	651,397	123
Malden, Mass	37	277,000	293	778,308	110
Manchester, N. H	35	1,014,180	463	1,797,518	80
Memphis, Tenn	663	2,849,010	2,556	4,324,377	41
Milwaukee, Wis	1,081	5,552,475	5,068	11,841,713	19
Minneapolis, Minn	58	3,389,900	6,055	13,092,390	16
Mobile, Ala	63	201,832	374	526,214	129
Montgomery, Ala	90	354,927	465	611,845	124

[a] No permits were issued for additions etc., in Dubuque.

Building statistics of the leading cities of the United States, by character of operations, in 1909—Continued.

City.	Fire-resisting buildings—Continued. Total. Number of permits or buildings.	Fire-resisting buildings—Continued. Total. Cost.	Grand total. Number of permits or buildings.	Grand total. Cost.	Rank of cities in cost of buildings erected in 1909.
Nashville, Tenn	361	$1,053,114	2,231	$1,676,572	84
Newark, N. J	779	7,983,278	3,082	14,177,159	11
New Bedford, Mass	75	3,657,600	986	6,267,650	30
Newcastle, Pa	11	65,000	41	165,000	137
New Haven, Conn	258	2,342,083	1,047	4,226,322	43
Newton, Mass	22	372,950	272	1,005,740	105
New York, N. Y	6,345	181,918,337	7,629	186,047,477	1
Norfolk, Va	409	1,793,468	807	2,456,953	62
Oakland, Cal	49	1,259,691	3,286	5,318,512	35
Omaha, Nebr	277	4,354,825	1,606	7,204,140	27
Passaic, N. J	115	1,389,740	419	2,300,727	67
Paterson, N. J	158	1,391,251	842	2,554,210	60
Pawtucket, R. I	19	728,400	318	1,245,959	96
Peoria, Ill	107	624,241	607	1,547,166	86
Philadelphia, Pa	16,499	42,570,770	17,294	42,881,370	4
Pittsburg, Pa	1,083	7,804,687	2,503	14,026,888	12
Portland, Oreg	802	6,461,315	4,739	13,481,380	13
Providence, R. I	148	1,442,100	1,788	5,340,500	34
Quincy, Ill	48	375,700	88	458,400	131
Reading, Pa	458	1,046,900	458	1,046,900	104
Richmond, Va	772	3,125,417	1,378	3,574,812	49
Rochester, N. Y	308	2,975,381	3,122	9,272,132	23
Rockford, Ill	76	309,000	1,228	819,000	108
Sacramento, Cal	60	790,079	515	2,063,395	74
Saginaw, Mich	48	185,787	245	331,617	133
St. Louis, Mo	4,386	22,422,929	9,279	23,733,272	6
St. Paul, Minn	451	6,363,478	4,158	12,158,354	18
Salem, Mass	8	110,000	255	687,058	119
Salt Lake City, Utah	1,063	7,789,420	1,288	8,077,820	25
San Antonio, Tex	137	1,466,139	3,413	3,453,598	50
San Francisco, Cal	654	13,124,987	5,773	26,184,068	5
Schenectady, N. Y	81	939,778	689	1,899,445	78
Scranton, Pa	109	2,410,995	975	3,987,943	44
Seattle, Wash	2,794	7,945,276	14,884	19,044,335	7
Somerville, Mass	17	194,000	373	1,443,729	90
South Omaha, Nebr	17	57,900	231	284,750	135
Springfield, Ill	112	575,655	638	1,385,510	92
Springfield, Mass	586	4,395,000	1,212	5,645,000	31
Superior, Wis	18	397,014	158	735,899	114
Syracuse, N. Y	166	1,887,661	1,573	4,855,811	37
Tacoma, Wash	39	2,916,800	2,434	5,482,208	33
Taunton, Mass	10	243,000	44	735,000	115
Terre Haute, Ind	113	311,755	763	908,260	107
Toledo, Ohio	230	1,573,667	1,314	2,014,462	75
Topeka, Kans	60	904,032	659	1,511,791	88
Trenton, N. J	819	2,049,567	1,277	2,350,366	65
Troy, N. Y	154	898,725	363	1,187,325	98
Washington, D. C	7,347	12,281,005	9,935	15,468,635	9
Wheeling, W. Va	127	733,447	341	933,540	106
Wichita, Kans	82	1,570,900	1,251	3,629,660	47
Wilkesbarre, Pa	132	1,226,382	646	2,121,234	71
Wilmington, Del	716	1,742,309	739	1,760,700	81
Worcester, Mass	165	1,927,920	1,270	4,314,435	42
Yonkers, N. Y	172	1,781,050	416	2,462,850	61
York, Pa	576	608,000	647	686,300	120
Youngstown, Ohio	170	885,135	1,081	2,100,686	73
Total	99,068	654,930,722	264,536	903,385,954	
Per cent of total		72.50		100.00	
La Crosse, Wis			(a)	550,000	128
Little Rock, Ark			935	1,531,097	87
New Orleans, La			2,795	5,165,212	36
Portland, Me			386	3,000,000	54
St. Joseph, Mo			937	2,255,759	68
South Bend, Ind			331	716,465	117
Spokane, Wash			2,963	8,766,226	24
Waterbury, Conn			763	3,900,000	45
Woonsocket, R. I			237	1,250,000	95
Grand total			273,883	930,520,713	

a No permits were issued in La Crosse.

This table shows that the 137 cities included reported for 1909 building operations costing $930,520,713 under 273,883 permits. Of these cities, 128 reported 264,536 permits, work under which cost $903,385,954. Of these totals, the new buildings constituted 90.3 per cent of the cost and the additions, alterations, and repairs 9.7 per cent. Taken by classes, the new wooden buildings constituted 24.16 per cent of the cost, and the additions, alterations, and repairs to wooden buildings 3.34 per cent; new brick buildings 55.82 per cent, additions, etc., 5.67 per cent; new stone buildings 3.1 per cent, additions 0.25 per cent; new concrete buildings 3.39 per cent, additions 0.13 per cent; all other fire-resisting buildings 3.83 per cent, additions 0.31 per cent. Of the cost of new buildings 73.24 per cent was for fire-resisting buildings and 26.76 per cent for wooden buildings. Of the cost of all new fire-resisting buildings 84.39 per cent was for brick buildings, 4.69 per cent for stone buildings, 5.13 per cent for concrete buildings, and 5.8 per cent for miscellaneous fire-resisting buildings. Of the cost of additions, alterations, and repairs, 34.45 per cent was for wooden buildings, and 65.55 per cent for fire-resisting buildings. Of the last item 89.27 per cent was for brick buildings; 3.84 per cent for stone buildings; 1.96 per cent for concrete buildings; and 4.93 per cent for all other additions and repairs.

Operations on brick buildings (new buildings, additions, alterations, and repairs) constituted 61.49 per cent of the entire cost of all operations in these 128 cities, all other fire-resisting buildings amounting to but 11.01 per cent. This shows conclusively the great popularity of brick as a building material.

Wooden buildings.—The average cost in 1909 for new wooden buildings was $2,269, for new brick buildings $9,522, for stone buildings $11,679, for concrete buildings $17,099, and for miscellaneous fire-resisting buildings $63,890.

Seattle had the largest number of new wooden buildings, 7,355, with an average cost of $1,338 each. Los Angeles was second in number of wooden buildings, 5,284, with an average cost of $1,553 each.

Chicago was the leading city in the cost of wooden buildings, reporting a total of $13,532,880 and an average of $4,912 in 1909, as compared with $4,659 in 1908. San Francisco was second with a total of $12,257,683, and an average of $4,186; and Seattle was third with a total cost of $9,843,805. Reading was the only city that reported no wooden buildings erected. New York reported 823 permits for buildings of wood costing $3,697,555, an average cost of $4,492; these were almost entirely in the borough of the Bronx. In Philadelphia but 24 new wooden buildings were erected at a total cost of $38,000, or an average cost of $1,583.

Fire-resisting buildings.—New York reported the construction of fire-resisting buildings at a cost of $181,918,337, or 27.78 per cent of the total for this class of buildings; Chicago was second, with a cost of $79,105,500, or 12.08 per cent of the total; Brooklyn was third, reporting fire-resisting buildings costing $54,658,721, or 8.35 per cent of the total; Philadelphia was fourth, with $42,570,770, or 6.5 per cent of the total. St. Louis, which was sixth in total cost of building operations, was fifth in cost of fire-resisting buildings, with $22,422,929, or 3.42 per cent of the total, displacing San Francisco, which was sixth in fire-resisting buildings, and reported $13,124,987, or 2 per cent of the total cost of fire-resisting buildings. Washington was ninth in cost of all buildings, but seventh in cost of fire-resisting buildings, surpassing Seattle and Boston. Denver was eighth in rank in the cost of fire-resisting buildings, with $11,438,893; this city was twentieth in cost of all buildings. No other city reported fire-resisting buildings costing as much as $10,000,000. It is interesting to note that Seattle, which was seventh in cost of building operations, was fourteenth in cost of fire-resisting buildings; Boston was eighth in total cost and ninth in cost of fire-resisting buildings; Detroit, tenth and twelfth, respectively; Cleveland, seventeenth and eleventh; Newark, eleventh and thirteenth; Pittsburg, twelfth and fifteenth; Salt Lake City, twenty-fifth and sixteenth. The average cost of operations of all kinds on fire-resisting buildings in New York was $28,671; in Chicago, $6,236; in Brooklyn, $5,807; in Philadelphia, $2,580; in St. Louis, $5,112; in San Francisco, $20,068; in Washington, $1,672; in Denver, $3,691; in Boston, $6,519; in Baltimore, $3,129; in Cleveland, $5,864; in Detroit, $12,465; in Newark, $10,248; in Seattle, $2,844; and in Pittsburg, $7,207.

The average cost of new fire-resisting buildings in the 15 cities reporting the greatest cost for this class varied from $3,151 in Philadelphia to $65,384 in New York. The average cost of new fire-resisting buildings in these cities was as follows: New York, $65,384; Chicago, $9,077; Brooklyn, $6,564; St. Louis, $7,487; San Francisco, $38,389; Washington, $7,886; Denver, $4,092; Boston, $18,681; Baltimore, $3,560; Cleveland, $8,275; Detroit, $13,292; Newark, $12,138; Seattle, $51,900; Pittsburg, $8,229; Philadelphia, $3,151. The greatest proportional difference between the average cost of new buildings and the average cost of all work done on fire-resisting buildings was in Seattle, where the average cost of new buildings was $51,900 and the average cost of all operations was $2,844, the difference being $49,056. Of Seattle's 7,494 new buildings, 98.15 per cent were wooden and 1.85 per cent were fire-resisting, but this small number of fire-resisting buildings amounted to 42.29 per cent of the cost of all new buildings. Evidently Seattle's fire-resisting buildings were few, as their average cost was second only to that of New York.

In considering the various classes of fire-resisting buildings, it should be borne in mind that the figures for these items are not exact, since it was not possible to get detailed statistics for the following cities: Baltimore, Brooklyn, Detroit, Minneapolis, St. Louis, and Syracuse. In these cities all fire-resisting building operations were classified under brick buildings. This is manifestly inaccurate, as, for instance, it ranks Brooklyn as second in the cost of new brick buildings and Chicago as third, with about $600,000 less. If, however, Brooklyn's stone, concrete, and other buildings of this character were properly distributed, then the cost of Brooklyn's brick buildings would fall considerably below that of Chicago. For the new brick buildings of Chicago cost $51,145,400, whereas under the $51,747,760 are included all new fire-resisting buildings in Brooklyn. Hence, justice is not done the stone, concrete, and other fire-resisting buildings by the table, since for these 6 cities a considerable number of these buildings must be included with the brick buildings. The table is given as presenting the best statistics on the subject that it was possible to obtain and is believed to show accurate totals both for the two general classes and for the grand total. As they stand, the figures show that New York was the leading city in new brick buildings and reported a cost of $151,832,438, or an average of $60,395 per building; Brooklyn was second with $51,747,760, an average of $6,564; Chicago was third with $51,145,400, an average cost of $8,581, and Philadelphia fourth with $30,653,580, an average cost of $2,956. In number of brick buildings, assuming that one permit is issued for each building, Philadelphia was first, reporting 10,370 buildings; Brooklyn second, with 7,884 buildings; and Chicago third, with 5,960 buildings.

In stone buildings Chicago was the leading city, and reported 83.69 per cent of the stone buildings erected and 57.08 of the cost of these buildings, with an average cost of $7,965; New York was second, with an average cost of $111,677; San Francisco was third, with an average cost of $149,086. These three cities reported 80.62 per cent of the cost of all the stone buildings reported in these 128 cities.

The leading city in the number and cost of concrete buildings was Chicago, which reported 519 buildings, costing $9,894,800, or 32.31 per cent of the cost of all concrete buildings. The city ranking second in cost of concrete buildings was Seattle, which reported $2,872,400, or 9.38 per cent of the total, followed closely by Philadelphia with $2,014,300, or 6.58 per cent of the total. Out of the 128 cities reporting, 79 erected new concrete buildings, 1,791 in number, which shows the widespread use of this material as a building agent.

Miscellaneous fire-resisting buildings, which include steel skeleton buildings, were reported from 39 cities. New York was the leading city in this class of buildings, reporting them to the cost of $12,863,100, with Newark second, with a cost of $3,323,000.

CLAY.

Clay available for the manufacture of clay products is one of the most widely spread of our minerals. Hence there are clay-working plants scattered over every State and Territory in the Union. Clay miners are usually also the manufacturers of the lower-grade clays, but as the higher grades of ware are reached the rule is that fewer and fewer manufacturers are also miners, until in the highest grades of ware the rule is that the manufacturer is not the miner of the c ays that he uses. The figures given in the following tables represent clay that is mined and not manufactured by the miner, but is sold as clay. The clay thus sold is small in quantity compared with that consumed, and includes mainly clay used for high-grade pottery, for paper making, and for refractory products.

The clay-mining industry in 1909, in common with the clay-working industries, enjoyed a year of prosperity. The total quantity and value of the clay mined for sale and not for consumption by the miner was 2,159,647 short tons, valued at $3,449,707, as compared with 1,723,901 short tons, valued at $2,599,986 in 1908. This was an increase of 435,746 short tons, or 25.28 per cent, in quantity and of $849,721, or 32.68 per cent, in value. This is the largest value reported for clay mined, being greater by $1,159 than that reported for 1907, the largest up to that time, though the output of 1907 was 24,032 tons greater than that of 1909. The average price per ton in 1909 was $1.60; for 1908 it was $1.51, and for 1907, $1.58.

In the tables following will be found statements of the clay mined and sold as such by the miner in 1908 and 1909.

Clay mined and sold in the United States in 1908, by States, in short tons.

State.	Kaolin.		Paper clay.		Slip clay.		Ball clay.		Fire clay.		Stoneware clay.		Brick clay.		Miscellaneous.[a]		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Alabama									68,289	$48,983			(b)	(b)	24,000	$12,000	93,289	$61,733
Arizona[c]	(b)	(b)					(b)	(b)	1,706	8,512					1,614	3,507	24,910	134,771
California									65,411	87,311	9,935	$8,959	(b)	(b)	2,000	2,500	80,586	99,094
Colorado									32,925	28,101	(b)	(b)	33,165	$24,218	2,949	5,161	69,578	58,380
Georgia			18,230	$87,540	(b)	(b)			13,805	9,005	666	2,025	1,118	3,024	4,096	4,433	37,916	106,028
Illinois									39,075	47,039	29,102	23,397	(b)	(b)	26,858	21,999	117,082	114,482
Indiana									59,841	55,187	4,614	5,614	(b)	(b)	8,060	8,300	74,015	72,101
Iowa									6,234	1,990			(b)	(b)	500	500	9,134	3,690
Kentucky							(b)	(b)	42,352	33,653	(b)	(b)	(b)	(b)	300	225	60,930	55,188
Maryland	(b)	(b)	(b)	(b)					4,581	9,807	1,125	1,538	(b)	(b)	2,575	2,225	11,881	28,395
Massachusetts									1,349	3,015			5,702	3,492	469	280	7,520	6,787
Michigan					1,882	$5,571									100	375	1,982	5,946
Missouri	138	$974							124,970	238,747	7,061	4,005	24,089	20,298	500	500	156,758	264,524
Montana									6,264	9,553			(b)	(b)			6,364	9,953
New Jersey							1,135	$5,514	234,579	382,373	8,358	15,109	25,495	27,854	42,665	76,353	312,232	507,203
New Mexico									18,840	27,929							18,840	27,929
New York					(b)	(b)			(b)	(b)					1,287	2,181	4,277	11,186
North Carolina	10,532	85,300									2,098	249			200	100	12,830	85,649
Ohio					(b)	(b)			151,416	125,684	49,957	30,804	38,360	14,652	1,804	1,423	242,737	174,063
Oregon									897	2,585	(b)	(b)					1,054	2,742
Pennsylvania	4,813	26,549	18,309	110,317					179,555	297,196	5,784	4,731	26,280	19,086	8,416	8,506	243,157	466,385
South Carolina			26,321	107,586					624	3,050							26,945	110,636
Tennessee					(b)	(b)	19,058	48,556	1,375	2,893	4,345	4,431			14,027	19,910	40,605	77,680
Texas	(b)	(b)							2,143	7,405	(b)	(b)	(b)	(b)	670	2,383	16,584	19,064
Utah									17,267	22,894					80	160	17,347	23,054
Vermont	3,793	29,398	(b)	(b)					(b)	(b)							4,474	34,092
Virginia	(b)	(b)							(b)	(b)					60	22	442	3,250
Washington					(b)	(b)			653	5,921	(b)	(b)			200	500	3,883	15,511
West Virginia									26,189	20,307	(b)	(b)			60	13	26,549	20,470
Other States[d]	9,373	74,022	1,650	5,500	8,205	16,799	20,645	79,700	1,239	6,999	1,147	1,528	56,347	41,951			(e)	(e)
Total	28,649	216,243	64,510	310,943	10,087	22,370	40,838	133,770	1,101,579	1,486,139	124,192	102,390	210,556	154,575	143,490	173,556	1,723,901	2,599,986
Average value per ton		7.55		4.82		2.22		3.28		1.35		0.82		0.73		1.21		1.51

[a] Including bentonite, pipe clay, shale, terra-cotta clay, wad clay, and clay for medicinal use.
[b] Included in "Other States."
[c] Including Delaware, Florida, Idaho, North Dakota, Wisconsin, and Wyoming.
[d] Includes all products which could not be published separately without disclosing individual figures.
[e] The total of "Other States" is distributed among the States to which it belongs in order that they may be fully represented in the totals.

State.	Kaolin.		Paper clay.		Slip clay.		Ball clay.		Fire clay.		Stoneware clay.		Brick clay.		Miscellaneous clay.[a]		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Alabama									45,137	$35,345					18,271	$5,587	63,408	$40,932
Arizona [b]	(c)	(c)			1,317	$3,945	17,636	$115,001	4,789	15,500			10	$50	1,085	1,365	32,136	193,398
California									35,035	36,458	(c)	(c)	(c)	(c)	10,426	10,281	63,441	78,131
Colorado									46,151	41,846			63,058	50,953			109,209	92,799
Georgia			31,617	$147,753					(c)	(c)	(c)	(c)	(c)	(c)	3,391	3,650	38,320	159,606
Illinois									45,806	73,884	33,098	$27,886	26,255	19,943	38,901	29,155	144,060	150,868
Indiana									65,939	60,194	4,500	5,100	7,417	6,066	2,518	1,000	80,374	72,360
Iowa									(c)	(c)			39,928	17,302			43,428	17,817
Kentucky					(c)	(c)	(c)	(c)	31,063	28,727			(c)	(c)	(c)	(c)	45,621	59,200
Maryland	(c)	(c)							15,971	23,301	1,350	1,621	953	1,300	5,850	11,815	26,124	50,537
Massachusetts									(c)	(c)			(c)	(c)	50	108	3,850	2,608
Missouri	(c)	(c)					(c)	(c)	205,792	420,911	751	686	4,229	1,689	(c)	(c)	214,527	462,668
Montana									8,862	22,482							8,862	22,482
New Jersey							(c)	(c)	320,447	554,604	16,329	34,631	15,946	19,522	54,689	69,631	410,103	694,566
New Mexico									13,757	23,229							13,757	23,229
New York					(c)	(c)			(c)	(c)					997	698	4,498	14,083
North Carolina	(c)	(c)									424	753					12,097	99,174
Ohio					(c)	(c)			183,897	151,287	55,644	42,850	(c)	(c)	9,821	8,062	284,482	216,543
Pennsylvania	4,238	$26,841	18,113	106,228					342,496	494,235	(c)	(c)	9,711	10,375	4,509	6,337	379,387	644,411
South Carolina			31,856	132,783					(c)	(c)					650	559	33,151	137,089
Tennessee							24,459	68,360	18,098	21,602	10,573	12,987			7,875	9,400	61,005	112,349
Texas	(c)	(c)							796	3,027							816	3,574
Utah									6,662	10,334			(c)	(c)			13,773	13,934
Vermont	(c)	(c)							(c)	(c)					990	3,960	5,480	35,465
Washington									6,220	10,129					100	200	6,320	10,329
West Virginia									60,428	40,422	(c)	(c)			570	713	61,418	41,555
Other States [d]	26,989	214,219			16,693	26,582	6,979	30,833	6,573	14,676	8,088	10,750	55,179	43,983	1,695	24,001	(e)	(e)
Total	31,227	241,060	81,586	386,764	18,010	30,527	49,074	214,194	1,463,919	2,082,193	130,757	137,264	222,686	171,183	162,388	186,522	2,159,647	3,449,707
Average value per ton		7.72		4.74		1.70		4.36		1.42		1.05		.77		1.15		1.60

[a] Including bentonite, modeling clay, pipe clay, shale, and terra cotta clay.
[b] Including Delaware, Florida, Idaho, Kansas, Michigan, Minnesota, Mississippi, North Dakota, Oregon, Virginia, Wisconsin, and Wyoming.
[c] Included in "Other States."
[d] Includes all products which could not be published separately without disclosing individual figures.
[e] The total of "Other States" is distributed among the States to which it belongs in order that they may be fully represented in the totals.

The leading clay-producing State in 1908, as for several years, in both quantity and value, was New Jersey. In 1909 the production in this State increased 97,871 short tons, or 31.35 per cent, and the value showed a gain of $187,363, or 36.94 per cent. In 1909 New Jersey reported 18.99 per cent of the quantity of clay produced in the country and 20.13 per cent of its total value. Of New Jersey's product, 78.14 per cent was fire clay, and of the value of the clay reported for the State 79.85 per cent was for fire clay. The production of stoneware clay was nearly twice as large in this State in 1909 as in 1908, and the value more than twice as great. The average value per ton for all clay in 1909 in New Jersey was $1.69; in 1908 it was $1.62; and in 1907, $1.53. Pennsylvania was the second State in the production and value of clay in 1909, as in 1908 and 1907, and reported 17.57 per cent of the clay produced in the country and 18.68 per cent of the value. This was a gain of 136,230 short tons, or of 56.03 per cent, in quantity and of $178,026, or 38.17 per cent in value. The average value per ton of all clay in Pennsylvania in 1909 was $1.70. In this State fire clay was also the leading variety, 90.28 per cent of the quantity and 76.70 per cent of the value being fire clay.

Ohio, the leading clay-working State, was third in quantity of clay marketed and fourth in value, and Missouri was fourth in quantity and third in value. Ohio showed an increase over 1908 of 41,745 tons, or 17.20 per cent, and of $42,480 in value, or 24.40 per cent. Missouri showed a gain of 57,769 short tons, or 36.85 per cent, and of $198,144, or 74.91 per cent, in value. The average price received per ton for all clay in 1909 in Ohio was 76 cents and in Missouri $2.16; in 1908 these averages were 72 cents and $1.69, respectively.

Eighteen States reported increase in production in 1909 and 19 reported increase in value. Kentucky and North Carolina each reported a decrease in quantity and an increase in value, and Washington reported an increase in quantity and a decrease in value. Every variety increased in quantity and value in 1909. Kaolin showed an increase of 2,578 short tons, or 9 per cent, in quantity and of $24,817, or 11.48 per cent, in value. The production of paper clay increased 17,076 short tons, or 26.47 per cent, in quantity and $75,821, or 24.38 per cent, in value; ball clay increased 8,236 short tons, or 20.17 per cent, in quantity and $80,424, or 60.12 per cent, in value; fire clay 362,340 tons, or 32.89 per cent, and $596,054, or 40.11 per cent, respectively. Fire clay was the clay of greatest importance, judged from the quantity and value reported. In 1909 it was 67.79 per cent of the quantity of all clay reported, and 60.36 per cent of the total value. Pennsylvania was the leading fire-clay-producing State in quantity though second in value. New Jersey was second in quantity and first in value, and Missouri was third and Ohio fourth in both quantity and value. The average value per ton of fire clay in these four States in 1909 was: Missouri, $2.05; New Jersey, $1.73; Ohio, $0.82; and Pennsylvania, $1.44; in 1908 these prices were $1.91, $1.63, $0.83, and $1.66, respectively.

The average value per ton for paper clay, slip clay, and miscellaneous clays decreased in 1909; but as these clays are produced in relatively small quantities, their lower averages were not sufficient to overcome the increases, and the general average price per ton for all clay increased from $1.51 per ton in 1908 to $1.60 in 1909.

Imports.—The following table shows the imports of clay from 1905 to 1909:

Classified imports of clay for consumption, 1905–1909, in short tons.

Year.	Kaolin or china clay.			All other clays.						Total.	
				Unwrought.		Wrought.		Common blue.			
	Quantity.	Value.	Average value per ton.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1905	187,803	$1,019,650	$5.43	30,661	$151,583	1,560	$38,036	5,909	$54,390	225,933	$1,263,659
1906	223,404	1,208,189	5.41	33,267	166,366	1,889	37,549	9,220	84,578	267,780	1,496,682
1907	239,923	1,582,893	6.60	31,196	145,698	2,520	81,155	12,378	110,686	286,017	1,920,432
1908	176,895	1,129,847	6.39	27,730	129,411	1,372	22,990	4,872	37,053	210,869	1,319,301
1909	246,381	1,505,779	6.11	30,147	134,978	1,906	50,632	12,346	104,401	290,780	1,795,790

The imports of clay, except of kaolin or china clay, are unimportant. In 1909, of the total quantity of clay imported, 84.73 per cent, and of the total value, 83.85 per cent, were kaolin or china clay.

The increase in imports was general, every item showing a gain. Kaolin increased 69,486 tons, or 39.28 per cent, in quantity and $375,932, or 33.27 per cent, in value. In 1909 the imports of kaolin reached the maximum quantity; though the value for that year was $77,114 less than that of 1907, the maximum value.

The total quantity of clay imported in 1909 increased 79,911 tons, or 37.90 per cent, and the total value increased $476,489, or 36.12 per cent.

GLASS SAND, OTHER SAND, AND GRAVEL.

By Ernest F. Burchard.

PRODUCTION.

The total production of sand and gravel in the United States in 1909 was 59,565,551 short tons, valued at $18,336,990. This represents a net increase in quantity of 22,349,507 short tons, and in value of $5,066,958, over the production of 1908, and exceeds the production of 1907 by 17,713,633 short tons in quantity, and by $3,844,921 in value. In the year 1909 there was considerable activity in the building trades, especially in concrete construction work, consequently there was a large increase in the consumption of sand and gravel for building purposes. The production grouped under "other sand" showed a large increase in 1909, which was principally due to the increased quantities of material reported as used in railroad ballast and filling. Molding sand showed a relatively large increase in quantity, namely, over 51 per cent, and an increase of nearly 60 per cent in value over the production for 1908.

The production of glass sand in 1909 was 1,104,451 short tons, valued at $1,163,375. These figures represent only a slight increase over the production of 1908. The average value of glass sand per ton was $1.05 in 1909, a very slight increase over the average value in 1908. The average value of molding sand per short ton in 1909 was a little less than 70 cents, and of fire sand slightly under 84 cents per short ton. The other grades of sand bring much lower prices, the average ranging from about 20 cents per ton in the case of sands for filling, stone sawing, etc., to nearly 53 cents for furnace sand. The average value of building sand was about 31 cents per short ton. The average value per ton for gravel in 1909 was 25 cents, a decrease of nearly 5 cents per ton since 1908. The gravel figures include, under Missouri, 1,248,927 tons of "chats" or tailings from the zinc mines of the Flat River-Bonneterre and Joplin districts, and, under Alabama and Tennessee, a considerable quantity of chert, which is used for the improvement of roads.

The unit of measurement given in the following table of production is the short ton. Much of the sand is reported as sold by the cubic yard, a cubic yard varying in weight from 2,300 to 3,000 pounds, according to the condition of the sand and to the material of which the gravel is composed; also to the custom of the locality. All of the glass sand is sold by the short ton, and also a considerable quantity of the molding, building, and other sands; hence, the quantities reported were all reduced to this unit.

Production of glass sand, other sand, and gravel in the United States in 1908 and 1909, by States and uses, in short tons.

1908.

State.	Glass sand.		Molding sand.		Building sand.		Fire sand.		Engine sand.		Furnace sand.		Other sand.		Gravel.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Alabama			57,370	$20,683	175,404	$66,805			16,250	$1,750			5,662	$3,018	93,148	$85,893	348,134	$181,179
Arizona																	(a)	(a)
Arkansas	2,065	$1,297	1,790	1,136	96,936	11,910			8,586	3,211			22,958	6,548	119,652	31,750	251,987	98,852
California	6,805	5,121	3,861	3,811	31,718	11,973	2,888	$2,310	21,299	1,298	3,750	$2,000	20,571	15,277	521,713	96,170	612,605	140,960
Colorado	1,000	1,250	1,112	970	11,608	3,662							149	234	9,562	4,460	23,731	10,576
Connecticut			1,272	2,135	9,885	5,185							2,500	1,100			13,657	8,420
Delaware			20	20	31,713	13,885			18,961	7,584	12,682	5,890	12,617	5,047			78,993	32,426
Florida			1,494	784	12,350	5,651									14,332	11,466	28,176	17,901
Georgia	3,950	3,180	10,668	10,336	171,547	41,141	112	281	5,625	1,500			10,795	5,282	23,850	16,268	229,847	80,988
Illinois	191,722	139,172	143,080	86,213	1,342,303	481,827	2,935	1,395	84,455	11,147	36,235	16,209	2,047,147	175,941	2,806,871	591,118	6,657,748	1,503,022
Indiana	18,000	13,950	48,915	32,608	1,098,703	277,757			50,706	6,160	26,031	4,369	939,131	84,539	1,092,169	276,125	3,273,955	695,808
Iowa			1,544	5,054	485,805	205,121	25	30	26,032	5,811	2,500	875	45,157	11,009	209,449	55,544	773,512	286,444
Kansas					261,557	40,667			1,291	698			17,626	3,011	36,676	10,952	320,150	64,328
Kentucky	5,990	4,283	29,740	17,692	280,891	144,317			3,381	1,754	795	525	14,151	9,771	303,350	157,438	638,298	335,780
Louisiana	2,695	1,911			163,675	54,089			8,563	3,113			78,100	15,700	561,407	178,500	817,440	253,313
Maine																	(a)	(a)
Maryland	14,000	13,700	1,750	3,900	452,347	189,881			1,700	1,055			8,350	5,102	321,087	190,228	802,234	401,166
Massachusetts	5,017	25,330	6,257	6,085	84,617	43,430	5,000	3,250					9,382	8,165	48,775	28,919	159,048	115,179
Michigan	17,000	34,000	4,584	2,892	474,238	228,395			1,991	319	3,329	3,828	29,187	6,850	312,262	94,081	842,591	370,365
Minnesota			23,212	21,756	124,575	62,991			5,403	861			7,165	3,669	289,651	67,376	450,306	156,659
Mississippi			337	320	27,687	11,588	375	405	625	655	625	655			132,928	65,496	162,577	82,119
Missouri	111,517	83,106	41,719	21,640	1,767,794	427,050	2,820	996	12,500	2,500	23,300	16,655	42,361	27,648	586,144	147,389	2,588,158	726,984
Montana																	(a)	(a)
Nebraska					439,200	67,275			12,484	2,889			62,032	8,964	13,250	1,300	526,966	80,428
New Jersey	56,775	46,379	358,688	186,544	1,216,549	274,418	58,798	60,667	41,218	16,437	8,045	3,474	124,611	42,923	275,747	81,336	2,140,461	712,178
New Mexico					1,500	1,850			250	400			1,000	5,000	5,500	4,800	8,250	12,050
New York	5,000	3,500	416,151	330,796	2,724,160	809,983	15,924	9,544	21,174	10,159			47,259	22,261	476,720	166,420	3,706,388	1,352,663
North Carolina			467	332	6,500	1,725									156	13	7,123	2,070
Ohio	92,487	94,825	343,154	244,164	1,198,933	434,592	12,287	9,881	31,450	14,512	64,980	58,938	48,663	26,228	704,756	255,238	2,496,710	1,138,378
Oklahoma			250	200	70,000	28,000							6,698	892	42,992	6,879	119,940	35,971
Oregon					251,353	316,044									364,681	208,940	616,034	524,984
Pennsylvania	405,028	484,353	359,161	262,467	1,596,610	691,316	16,884	16,987	127,967	82,954	51,709	33,887	621,916	391,562	938,167	239,530	4,120,442	2,203,056
South Carolina	1,970	1,596	441	269	3,931	1,470							62	75			6,404	3,410
South Dakota																	(a)	(a)
Tennessee			22,451	15,966	247,921	122,099	1,573	1,233	37,118	11,367	48,055	32,023	9,515	4,306	430,701	173,080	797,334	360,074
Texas			4,355	2,500	171,237	93,784			3,500	1,563			500	370	129,658	41,853	309,250	140,067

Utah	....	....	....	....	....	....	....	....	4,585	1,105	....	....	6,150	1,291	10,255	1,203	20,990	3,599
Vermont	....	....	719	486	2,125	1,950	....	....	....	....	....	....	77,500	38,750	562	450	80,906	41,636
Virginia	....	....	47,888	22,568	139,742	61,378	....	....	6,651	2,860	11,295	5,500	670	325	242,988	26,464	449,234	119,095
Washington	....	....	1,725	4,300	241,461	97,688	....	....	....	....	....	....	....	....	411,809	159,543	654,995	261,531
West Virginia	145,782	174,834	1,815	1,369	121,321	58,153	....	....	30,520	18,012	6,600	3,000	7,195	5,514	55,409	15,476	368,642	276,358
Wisconsin	3,750	2,812	41,687	32,806	418,231	152,768	1,757	879	23,171	3,707	....	....	12,651	4,328	360,800	115,455	862,047	312,755
Wyoming	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	(a)	(a)
Other States b	....	....	....	....	75,554	45,717	....	....	....	....	....	....	....	....	849,156	133,610	850,781	134,260
Total	1,093,553	1,134,599	1,980,677	1,342,802	16,037,681	5,635,538	121,678	107,858	610,486	221,687	302,931	187,828	4,340,034	944,030	12,729,004	3,695,696	37,216,044	13,270,032

a Included in other States.

b Includes Arizona, Maine, Montana, South Dakota, and Wyoming.

Production of glass sand, other sand, and gravel in the United States in 1908 and 1909, by States and uses, in short tons—Continued.

1909.

State.	Glass sand.		Molding sand.		Building sand.		Fire sand.		Engine sand.		Furnace sand.		Other sand.		Gravel.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Alabama			119,999	$57,236	169,567	$49,249			6,510	$1,993	100	$50	1,280	$950	314,322	$104,918	611,778	$214,396
Arizona																	(a)	(a)
Arkansas	b 4,487	b $2,575	(c)	(c)	245,510	80,578			8,650	2,975			4,317	3,448	825,651	162,470	1,088,615	252,046
California	(d)	(d)	e 28,002	e 32,068	227,391	105,197	4,681	$3,745	27,317	5,348			12,527	7,312	914,035	169,476	1,213,953	323,146
Colorado			6,544	3,840	21,882	13,639			4,140	1,800	7,003	4,563	27,372	14,574	335,752	56,965	402,693	95,381
Connecticut			1,069	1,117	14,015	10,740							675	625			15,759	12,482
Delaware			50	50	58,204	29,102			14,924	5,671	68,661	35,146	8,954	8,954			150,793	78,923
Florida			559	717	24,190	13,563							1,048	116	17,769	14,215	43,566	28,611
Georgia	(d)	(d)	e 18,776	e 10,067	266,673	135,208			9,986	2,997	4,000	800	91,923	19,106	44,418	39,435	435,776	207,613
Hawaii																	(a)	(a)
Idaho																	(a)	(a)
Illinois	224,381	153,226	288,518	143,922	1,917,915	632,273	2,370	1,473	104,882	11,242	22,840	13,700	3,188,885	277,056	3,405,438	716,605	9,155,229	1,949,497
Indiana	(d)	(d)	e 142,864	e 93,021	1,265,724	372,403	100	75	28,275	7,799	69,800	13,681	1,184,660	97,995	1,795,773	352,958	4,487,196	937,932
Iowa			26,463	35,340	774,101	260,727			21,895	5,280	3,700	1,480	49,794	9,722	654,951	146,280	1,530,904	458,829
Kansas					921,388	181,242			2,996	488			37,041	2,601	16,493	4,377	977,918	188,708
Kentucky	(d)	(d)	e 42,298	e 33,587	398,812	218,556	420	212	8,953	4,423	13,546	7,716	12,638	10,136	289,314	158,853	765,981	433,483
Louisiana					159,274	64,163			4,826	491			76,560	19,162	410,484	218,802	651,144	302,618
Maine																	(a)	(a)
Maryland	b 14,483	b 15,730	(c)	(c)	280,763	94,499			1,581	1,490			14,244	10,606	146,347	71,432	457,418	193,757
Massachusetts	(d)	(d)	e 24,190	e 29,572	178,510	90,196	4,000	2,600					11,366	8,677	113,403	74,652	331,469	205,697
Michigan	65,000	79,000	53,226	20,756	1,090,419	327,247	4,000	2,000	12,415	1,493	3,183	3,660	295,612	50,953	695,902	200,523	2,219,757	685,632
Minnesota			33,657	36,374	176,009	55,563			6,770	1,131	150	225	1,170	1,900	1,121,283	236,969	1,339,039	332,162
Mississippi			266	213	304,488	139,633							4,806	3,000	207,778	126,518	517,338	269,364
Missouri	98,480	73,082	70,136	38,578	1,867,734	440,021	4,640	1,160	44,167	11,577	29,925	18,120	280,139	65,317	1,933,031	353,476	4,328,252	1,001,331
Montana																	(a)	(a)
Nebraska					558,801	97,424			7,595	751			210,872	18,243	9,340	3,484	786,608	119,902
Nevada																	(a)	(a)
New Jersey	85,696	62,830	499,291	310,910	1,343,958	290,056	66,023	66,142	33,269	10,131	5,768	2,911	162,013	74,718	494,696	117,675	2,690,714	935,373
New Mexico					1,954	1,612									2,948	1,420	4,902	3,032
New York	(d)	(d)	e 477,121	e 423,172	3,986,875	885,918	23,136	12,436	21,193	10,702			67,188	29,157	1,824,102	464,929	6,399,615	1,826,314
North Carolina			409	282	15,500	4,935							73,272	8,141			89,181	13,358
Ohio	88,054	95,331	650,336	481,125	1,661,110	564,769	9,647	7,187	66,012	15,619	62,948	44,129	116,614	44,089	1,360,652	341,047	4,015,373	1,593,296
Oklahoma					441,556	130,040			10,620	1,560			22,824	6,250	206,785	47,962	681,785	185,812
Oregon					274,615	146,318							325,000	78,000	297,374	155,387	896,989	379,705
Pennsylvania	281,120	399,707	540,007	350,975	2,153,039	892,703	30,952	28,848	141,137	109,224	112,164	69,265	599,623	410,315	1,341,705	252,033	5,199,747	2,513,070

South Carolina	*b* 850	*b* 739	(*c*)	(*c*)	905	380	....	....	....	....	....	....	298,004	33,295	400	600	300,159	35,014
South Dakota	....	....	....	....	38,793	23,211	....	....	....	....	....	....	....	....	1,487,921	248,049	1,526,714	271,260
Tennessee	1,550	1,250	47,006	24,691	306,134	157,884	270	150	44,492	13,580	10,502	3,992	18,194	10,902	484,864	205,274	913,012	417,723
Texas	....	....	4,774	3,178	490,294	183.609	....	....	17,575	6,330	....	....	....	....	163,863	53,248	676,506	246,365
Utah	....	....	....	....	16,768	2,594	....	....	8,637	1,968	....	....	100	75	75,618	5,398	101,123	10,035
Vermont	....	....	1,820	1,207	2,877	970	....	....	93	38	....	....	75,350	6,215	1,950	322	82,090	8,752
Virginia	....	....	25,480	17,241	368,744	125,208	....	....	3,594	1,585	9,740	4,563	47,631	8,149	392,287	124,431	847,476	281,177
Washington	....	....	3,935	6,200	461,788	159,400	....	....	1,765	707	....	....	9,343	4,332	776,801	252,786	1,253,632	423,425
West Virginia	169,731	205,102	2,248	1,669	135,537	84,769	....	....	27,896	22,700	6,700	3,225	77,328	33,940	137,005	70,833	556,445	422,238
Wisconsin	(*d*)	(*d*)	*e* 84,381	*e* 63,915	479,808	163,610	1,000	750	32,244	5,057	473	355	200,215	58,155	719,312	122,427	1,517,433	414,269
Wyoming	....	....	....	....	532	355	....	....	....	....	....	....	....	....	198,867	15,524	199,399	15,879
Other states *f*	....	....	....	....	14,042	9,250	....	....	....	....	....	....	23,758	12,000	64,270	28,133	102.070	49.383
Total	*g* 1,033,832	*g* 1,088,572	*h* 3,193,425	*h* 2,221,023	23,116,199	7,238,814	151,239	126,778	724,409	266,150	431,203	227,581	*i* 7,632,340	*i* 1,448,186	23,282,904	5,719,886	59,565,551	18,336.990

a Included in other States.
b Includes molding sand.
c Included in glass sand.
d Included in molding sand.
e Includes glass sand.
f Includes Arizona, Hawaii, Idaho, Maine, Montana, Nevada, and North Dakota.
g The exact output of glass sand was 1,104,451 tons, valued at $1,163,375.
h The exact output of molding sand was 3,122,806 tons, valued at $2,146,220.
i Includes sand for grinding and polishing stone and glass, sand for filtration plants, sand for railroad filling and ballast, for molding brick, for making asphalt pavement and blocks, etc

WASHING SAND AND GRAVEL FOR CONCRETE AND MORTAR.

During the year 1909 field and laboratory studies were made by the United States Geological Survey of a large number of sands and gravels in localities where the construction of federal buildings had been authorized by Congress. One of the striking features brought out by these studies is the great variation in the quality of materials used for concrete aggregates in different places throughout the United States. Broadly, the sands and gravels in common use may be grouped into three classes on the basis of origin—(1) glacial deposits; (2) coastal plain deposits; (3) stream deposits. The deposits of the first and second classes have, in many instances, been modified by water action, and the third class may be considered as composed partly of materials derived from deposits of the first two classes and partly of materials derived directly from the breaking down of the country rock. All three classes of deposits contain more or less silt, clay, loam, or other very finely divided impurities.

In many communities the run-of-bank sand and gravel is used directly in concrete work without any attempt being made to clean it, except, perhaps in rare instances, by dry screening or rough sizing. In some cases it has been stated by local contractors that the run-of-bank made naturally just the correct theoretical mixture of sand and gravel to produce the least voids in concrete. In practically all cases it has been found by experiment that these suppositions were erroneous, and that to use run-of-bank material for structural concrete work is a haphazard and careless method. It is certain that under such conditions not only is the proportioning and the sizing of the mixture indefinite and variable, but that the large quantities of impurities which are unavoidably included tend to weaken the strength of the concrete. Where gravel is coated with dust or dirt of any kind, the cement is compelled to set against this film of foreign matter rather than against the gravel itself, and is consequently easily broken away from the stone. Where such impurities are mixed with the sand and gravel, the cement can not set perfectly and form a firm bond between the sand and gravel. In recent years, particularly in the large building centers, there has developed a greater appreciation of the importance of clean sand and gravel for use in concrete and mortar. Leading architects, engineers, and contractors are now demanding in their specifications sound, clean, washed materials, free from dust, loam, clay, or any kind of dirt. The soundness of the sand is an important consideration, since not all sands that look good and feel sharp prove to be satisfactory. Some sands are largely composed of grains of limestone and dolomite, and are softer than silica sand, and other sands may contain many grains of feldspar, which easily decays and crumbles. The presence of much mica in small flakes is also deleterious, as well as the presence of grains of pyrite and limonite. It is, of course, impossible to find deposits of sand and gravel that will yield 100 per cent of desirable material, but it is gratifying to note the improvement that may be effected in a sand or gravel by a suitable process of washing. Where sand or gravel is taken from below water in streams and lakes, a certain amount of washing is accomplished, whatever the process of excavating may be, but where the material is pumped up from a deep stream, agitated in clean water, screened, and drained, a very thorough cleaning is generally accomplished. In the case of bank deposits of sand and gravel, the material should be rolled and tumbled about in a rapid jet or stream of water, particularly streams that will size the material and deliver the oversize to a crusher. The crushed material is then returned to the washers and screens in the form of angular fragments, which are a very desirable addition to the aggregate.

Noteworthy examples of high quality river sands that are dredged or pumped and washed on a large scale are the Kaw River sand, near Kansas City, Mo., Mississippi River and Meramec River sands at St. Louis, Mo., and Mississippi River sand at Memphis, Tenn. The sands of the glaciated area in northern Illinois and southern Wisconsin are worked on a large scale to supply the important Chicago market, and these materials are invariably washed and screened. In many smaller, though important, building centers there is, however, a surprising lack of appreciation of the importance of preparing sand and gravel for building purposes. In one large city of the Middle West the practice has been until recently to use without washing the sand and gravel excavated from the cellar of a house for the mortar, concrete, and plaster that was needed in its construction. In many small buildings this plan works well enough, especially for concrete cellar floors and for sidewalks, but it is probable that better mortar and plaster might have been made had the sand been washed first. The disadvantages do not stop here, however, for all the surplus sand that may remain from the small operations is used in the construction of reenforced concrete buildings in the business section of the city, and the results have not always been what might have been desired. The locality referred to is well supplied with high-grade sand and gravel deposits that need only to be handled properly in order to produce concrete material of the most excellent type. Within the last year two plants have been erected; one dry screens the sand and gravel, the other washes and screens it; but in both cases the strong competition of the cheaper but inferior run-of-bank sand has had to be met.

In view of the present interest in the preparation of sand and gravel for mortar and concrete, a number of papers dealing with this subject have been listed in the bibliography at the end of this chapter.

ANALYSES OF SANDS.

From year to year many producers of sand who correspond with the Survey courteously send with their reports of production records of chemical analyses of their products. Enough of such data are now in hand to permit of their publication, and the following analyses are given for the purpose of affording general information as to the character and distribution of commercially available sands in the United States.

Analyses of sands quarried in various parts of the United States.

Location of deposit.	Owner.	Authority.	Silica (SiO_2).	Alumina (Al_2O_3).	Ferric oxide (Fe_2O_3).	Calcium oxide (lime) (CaO).	Magnesium oxide (MgO).	Loss by ignition (mostly water and organic matter).	Other minerals.	Total.	Remarks.
ALABAMA:											
Jefferson County—			*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*		*Per ct.*	
Gate City		Robert S. Hodges, University of Alabama.	98.80	0.75	0.31	0.05	0.10		Titanium oxide (TiO_2), 0.10 per cent.	100.11	Sand; deposit undeveloped.
Do		do	97.22	1.88	.24	.06	.09		Titanium oxide (TiO_2), 0.21 per cent.	99.70	Sandstone; deposit undeveloped.
Irondale		do	97.93	1.05	.19	.06	.33	0.51	Titanium oxide (TiO_2), 0.12 per cent.	100.19	Glass sand; deposit undeveloped.
North Birmingham.		do	97.30	1.39	.33	.07	.18	.57	Titanium oxide (TiO_2), 0.16 per cent.	100.00	Sandstone; undeveloped.
Trussville	Dr. S. W. Acton	Chemist, Southern Steel Co.	98.00							98.00	White sand.
Do	do	do	86.00							86.00	Molding sand.
Do	Trussville Sand Co	do	98.00							98.00	
Do		do	98.05	.22	.20	Trace.	.78			99.25	Glass sand; deposit undeveloped.
Do		do	86.50	1.03	4.57	3.28	2.17	2.10	Sodium oxide (Na_2O). Potassium oxide (K_2O). 0.28 per cent.	99.93	Molding sand.
Trussville (1 m. north of Acton Quarry).		Robert S. Hodges, University of Alabama.	98.30	.98	.19	.09	.02	.40	Titanium oxide (TiO_2), 0.09 per cent.	100.07	Glass sand; deposit undeveloped.
ARIZONA:											
Cochise County—											
Douglass (18 m. west of).	Calumet and Arizona Mining Co., Warren.	W. H. Worthington	87.03		(*a*)	2.50				91.57	
ARKANSAS:											
Boone County—											
Everton		George Steiger, U. S. Geological Survey.	99.55	.13	.09					99.77	Glass sand.

Izard County—		University of Nebraska.	[illegible]	Trace.	[illegible]	Trace.	Trace.	[illegible]		[illegible]	Do.
Do	Arkansas Silica Sand Co., Carthage, Mo.	W. George Waring, Webb City, Mo.	99.70	.11				.17	Calcium carbonate ($CaCO_3$), 0.02 per cent.	100.00	Do.
CALIFORNIA:											
Los Angeles County—											
Acton	C. E. Joslin, Los Angeles.	Julius Koebig	98.30	1.3		None.				99.60	Used for building sand.
Lancaster	Quartz Glass and Mfg. Co., Los Angeles.		98.80		Trace.	Trace.				98.80	Glass sand and building sand.
Santa Clara County—											
Saratoga	Stanfield & Knowles, Los Gatos.	Thomas Price & Son, San Francisco.	69.46	18.03	4.79	3.18	1.55	2.81	Loss and alkalies, 0.18 per cent.	100.00	
Yuba County—											
Marysville	C. F. Aaron	Continuous Glass Press Co., Philadelphia, Pa.	97.13	1.55	.61	.37		.34	Trace of gold	100.00	
FLORIDA:											
Escambia County—											
Pensacola		George Steiger, U. S. Geological Survey.	99.65			None.				99.65	Sea sand.
Marion County—											
Sandy Hook (near Lake Weir).	Lake Weir Sand and Stone Co.	R. E. Rose, Tallahassee, Fla.	99.90		Trace.		None.	.10		100.00	
GEORGIA:											
Bartow County—											
Emerson	Southern Silica Works.	Prof. McCandless and Dr. Eberhart.	88.00							88.00	
Muscogee County—											
Bull Creek (near Columbus).	Bull Creek Sand and Gravel Co., Columbus.	Pittsburg Testing Laboratory, Pittsburg, Pa.	96.07	2.17	.57	.15	.18	.40		99.54	Used for building sand.
Walker County—											
Near Chattanooga, Tenn.	A. W. Morse, Alton Park, Tenn.		98.37		1.72	Trace.				100.09	Molding sand.
ILLINOIS:											
Lasalle County—											
Ottawa	H. W. Bellrose Sand Co., Wedron.		98.00							98.00	White sand, crude; molding and grinding.
Do	do		90.00							90.00	Colored sand, crude; molding and grinding.
Do	do		99.90							99.90	Washed and dried; molding and grinding.

a Ferrous oxide (FeO), 2.04 per cent.

Analyses of sands quarried in various parts of the United States—Continued.

Location of deposit.	Owner.	Authority.	Silica (SiO_2).	Alumina (Al_2O_3).	Ferric oxide (Fe_2O_3).	Calcium oxide (lime) (CaO).	Magnesium oxide (MgO).	Loss by ignition (mostly water and organic matter).	Other minerals.	Total.	Remarks.
ILLINOIS—Cont'd.											
Lasalle Co.—Cont'd.			*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*		*Per ct.*	
Ottawa	Ottawa Silica Co	R. E. Lyons, University of Indiana.	99.45	0.30		0.13				99.88	Glass sand and grinding sand.
Do	...do	...do	99.82	.05		0.13				100.00	Glass sand, molding sand.
Do	United States Silica Co.	R. W. Hunt & Co., Chicago, Ill.	99.89	.051	Trace.		0.01			99.951	Glass sand, furnace sand.
Utica	E. J. Reynolds Co	Mariner & Haskins	99.576	.283	.0903	.0197	.002			99.971	Glass sand.
Do	Utica Fire Sand Co	Columbia Laboratories.	99.70							99.70	Glass sand, molding sand, furnace sand.
Wedron	Illinois Sand Co	R. W. Hunt & Co., Chicago, Ill.	95.06	3.88		.53	.18	0.35		100.00	Molding sand, fire sand.
Do	Wedron White Sand Co.	Cary & Moore, Chicago, Ill.	99.89		.051		.01			99.951	Glass sand.
Madison County—											
Alton	H. J. Bowman	Laboratory, Washington University, St. Louis, Mo.	99.87			.13				100.00	
Do	...do	R. W. Hunt & Co., Chicago, Ill.	98.82		1.03					99.85	
INDIANA:											
Clark County—											
Jeffersonville	Newport Sand Bank Co., Newport, Ky.	Laboratory, Cincinnati College of Pharmacy, Cincinnati, Ohio.	94.00	5.00	1.00	None.	None.			100.00	Fine-grained molding sand.
Floyd County—											
New Albany	...do	...do	92.00	1.50	5.00	Trace.				98.50	Fine, light-colored molding sand.
Fountain County—											
Attica	Western Silica Co., Danville, Ill.	State geologist of Indiana.	98.84	.38	.10		.03	.32	Titanium oxide, (TiO_2), trace.	99.67	
Hancock County—											
Maxwell	E. L. Dobbins, Greenfield.		85.00			.50	13.50		Loam, 1 per cent	100.00	

Brownstown	The Newport Sand Bank Co., Newport, Ky.	Cincinnati College of Pharmacy, Cincinnati, Ohio.	92.00	6.50	1.00	....	.50	....	....	100.00	Coarse red molding sand.
Laporte County—Michigan City	Pinkston Sand Co.	....	91.98	4.44	.56	2.20	Trace.	.72	Loss, 10 per cent	100.00	Molding sand, grinding sand.
Martin County—Loogootee	Loogootee Glass Sand Co.	J. F. Elson, New Albany.	97.78	1.13	.10	.06	....	....	....	99.07	Glass sand, selected sample.
Do	do	Operator, report of state geologist.	96.26	2.50	.92	....	.16	....	Potassium and sodium oxides (K_2O and Na_2O), 0.13 per cent.	99.97	Glass sand, crude.
Parke County—Coxville (near Rosedale).	Acme Glass Sand Co., Terre Haute.	W. A. Noyes, Rose Polytechnic Institute, Terre Haute.	98.61	.74	.22	.12	Trace.	.32	....	100.01	Glass sand, unwashed.
IOWA:											
Clayton County—Clayton	Clayton White Sand Co.	....	98.850	.480	FeO .095	.210	None.	.114	Potassium and sodium oxides (K_2O and Na_2O), 0.027 per cent.	100.019	Furnace sand.
Woodbury County—Sioux City (near Springdale station).	....	George Steiger, U. S. Geological Survey.	96.90	1.22	+FeO .28	.14	.05	1.07	....	99.66	Soft, friable sandstone.
KANSAS:											
Chautauqua County—Niotaze	George Tame	George Steiger, U. S. Geological Survey.	96.45	2.76	.37	....	....	....	....	99.58	Friable sandstone.
Do	do	do	96.90	2.03	.67	....	....	....	....	99.60	Do.
Greenwood County—Fall River, ¼ m. E. R. R. station.	....	do	97.28	.96	+FeO .80	.13	.04	.73	....	99.94	Do.
SE. ¼ sec. 13, T. 28 S., R. 12 E., No. 1.	....	do	98.24	.57	+FeO .35	.06	.04	.72	....	99.98	Friable sandstone undeveloped. Selected from different beds of same vertical section. Possibly good glass sand.
SE. ¼ sec. 13, T. 28 S., R. 12 E., No. 2.	....	do	97.81	.73	+FeO .35	.18	.05	.80	....	99.92	
SE. ¼ sec. 13, T. 28 S., R. 12 E., No. 3.	....	do	98.02	.81	+FeO .26	.08	.06	.81	....	100.04	
Montgomery County—Caney	A. B. Cochran	do	97.08	....	.72	....	....	....	....	97.80	Glass sand (?).
Havana	....	do	97.80	....	.84	....	....	....	....	98.64	Do.

Analyses of sands quarried in various parts of the United States—Continued.

Location of deposit.	Owner.	Authority.	Silica (SiO_2).	Alumina (Al_2O_3).	Ferric oxide (Fe_2O_3).	Calcium oxide (lime) (CaO).	Magnesium oxide (MgO).	Loss by ignition (mostly water and organic matter).	Other minerals.	Total.	Remarks.
KANSAS—Continued.											
Wilson County—			*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*		*Per ct.*	
Fredonia	F. Butts	George Steiger, U. S. Geological Survey.	97.50	1.62	0.43	0.10				99.65	Glass sand (?)
Do	Mrs. Hall	do	97.59		.33					97.92	Do.
Do	Orval Jeffers	do	97.94		.63					98.57	Do.
Do	C. D. Roberts	do	98.00		.37					98.37	Do.
Neodesha	Doolittle Place	do	98.71		.19					98.90	Do.
Wilson County—											
New Albany	Empire Brick and Gas Co.	W. W. Petraeus, Joplin, Mo.	98.20		1.65					99.85	
KENTUCKY:											
Bracken County—											
Augusta No. 2	The Augusta Sand Co.	P. F. Wehmer, Cincinnati, Ohio.	89.36	6.45	3.14	.67	Trace.			99.62	Molding sand.
Augusta No. 3	do	do	88.98	6.15	4.15	.56	Trace.			99.84	Do.
Augusta No. 4	do	do	87.88	7.01	2.15	.47	Trace.			97.51	Do.
Augusta No. 5	do	do	90.75	5.76	2.28	.73	Trace.			99.52	Do.
Campbell County—											
Newport	The Newport Sand Bank Co.	Cincinnati College of Pharmacy, Cincinnati, Ohio.	93.00	5.50	1.00		0.50			100.00	Medium machinery sand, coarse red molding sand.
Do	do	do	93.00	4.00	1.50	Trace.	1.00			99.50	Fine sand; light in color; molding sand.
Carter County—											
Olive Hill	Lawton Sand and Supply Co.	Laboratory, Agricultural Experiment Station, Lexington.	99.10	.39	.13	.03	Trace.	0.22	Titanium oxide (TiO_2), trace.	99.87	Glass sand.
Hardin County—											
Tip Top	Kentucky Silica Co., Louisville.	R. B. Hulme, Louisville.	99.14	.23	.02	.21	.08	.52		100.20	Glass sand; selected and washed.
Do	do	Operators of quarry	98.87	.21	.08	.24	.12		0.48 (?) per cent	100.00	Glass sand; selected.
Do	do	do	98.404	.751		.043	.372	.271		99.841	Glass sand; crude.

Visalia	The Newport Sand Bank Co., Newport.	Cincinnati College of Pharmacy, Cincinnati, Ohio.	93.00	5.00	1.00		1.00			100.00	Coarse grain, brown sand; molding sand.
Rockcastle County—Dudley	Winchester Granite Brick Co., Winchester.	Laboratory, Agricultural Experiment Station, Lexington.	96.67	1.81	.48	.02	.05	.75		99.78	Building sand.
MARYLAND:											
Allegany County—Cumberland	Cumberland Sand Co.	Maryland Geological Survey.	99.55	.30	None.	Trace.	None.	.10		99.95	Building sand; filtration sand.
Anne Arundel County—Robinson	Brennan Sand Co., Philadelphia, Pa.	J. G. Vail	99.50		.20				Clay, 0.30 per cent	100.00	Glass sand.
Do	do	A. E. Elkinton, Philadelphia, Pa.	98.80	1.00	.10		.10			100.00	Do.
MASSACHUSETTS:											
Berkshire County—Cheshire	Berkshire Glass Sand Co.	Worcester Polytechnic Institute, Worcester.	99.31	.58		.11				100.00	Glass sand.
Do	do	do	99.46	.48		.06				100.00	Do.
Do	do	State Assay Laboratory, Boston.	99.78	[a] .22		([b])				100.00	Do.
Plymouth County—East Wareham	J. H. Burgess		94.16	3.80	1.38	1.20		.49		101.03	Molding sand.
MICHIGAN:											
Macomb County—Armada	Henderson Gravel Co., Cleveland, Ohio.	W. J. Rattle & Son, Cleveland, Ohio.	83.80	7.80					Calcium carbonate ($CaCO_3$), 8.57 per cent.	100.17	
Wayne County—Rockwood	American Silica Co.	John E. Clark, Detroit.	99.70						Calcium carbonate ($CaCO_3$), 0.08 percent. Magnesium carbonate ($MgCO_3$), 0.22 percent.	100.00	Glass sand.
MISSOURI:											
Cape Girardeau County—Jackson	Jackson Lime and Quarry Co.	George Steiger, U. S. Geological Survey.	99.52	.16	.07					99.75	Do.
Franklin County—Grays Summit	White Sand Co. of Missouri, St. Louis.	Jno. F. Wixford	99.839		.0014			1.54		99.9944	Do.
Near Pacific	Stewart Supply Co., St. Louis.	Regis Chauvenet & Bro., St. Louis.	99.69			.31				100.00	Do.

[a] Includes calcium oxide, CaO.

[b] Included with alumina.

Analyses of sands quarried in various parts of the United States—Continued.

Location of deposit.	Owner.	Authority.	Silica (SiO_2).	Alumina (Al_2O_3).	Ferric oxide (Fe_2O_3).	Calcium oxide (lime) (CaO).	Magnesium oxide (MgO).	Loss by ignition (mostly water and organic matter).	Other minerals.	Total.	Remarks.
MISSOURI—Cont'd.											
Morgan County—Versailles		George Steiger, U. S. Geological Survey.	*Per ct.* 99.03	*Per ct.* 0.40	*Per ct.* FeO.13	*Per ct.* 0.29	*Per ct.* 0.11	*Per ct.* 0.44		*Per ct.* 100.40	Glass sand; undeveloped property.
St. Charles County—Klondike	Tavern Rock Sand Co., St. Louis.	Regis Chauvenet & Bro., St. Louis.	99.97	.03						100.00	Glass sand.
St. Louis County—Near Pacific	Pacific Glass Sand Co.	Laboratory, St. Louis Plate Glass Co., St. Louis.	99.20	.56		Trace.	.20	.08		100.04	Do.
NEBRASKA:											
Lancaster County—Robbers Cave (near Lincoln).		University of Nebraska, Lincoln.	95.76	.48	1.81	.24	.16		Undetermined, 1.55 per cent.	100.00	Crude; property undeveloped.
NEW JERSEY:											
Burlington County—Florence	E. M. Headrich	General Electric Co., West Lynn, Mass.	96.00							96.00	Molding sand; fire sand.
Wrightstown (Hanover).	Hanover Filtration Sand Co.	Booth, Garrett & Blair, Philadelphia, Pa.	97.62	2.40						100.02	
Camden County—Berlin (Tansboro).	S. W. Downer	T. A. Genth, Philadelphia, Pa.	99.65	.05	.08	.15	.01	.07		100.01	Glass sand; fire sand.
Gloucester County—Downer	do	New Jersey Geological Survey.	99.52	.1856	.0096	.006	.007	.19	Titanium oxide (TiO_2,) 0.0868 per cent.	100.005	Molding sand.
Williamstown	Weirich & Field, Philadelphia, Pa.	George E. Davis, Philadelphia, Pa.	97.90		.63					98.53	Do.
Do	do	do	98.89		.13					99.02	Glass sand.
Middlesex County—Jamesburg	Brookfield Glass Co., New York, N. Y.	Lederle Laboratories, New York, N. Y.	97.46	1.56	.26	.40		.32		100.00	Do.
Sayreville	Crossman & Co., South Amboy.		98.00							98.00	Molding sand; fire sand.

NEW YORK:											
Chemung County	C. W. Mooers	F. A. Richmond, Elmira College.	85.86	5.30	4.22	1.38	.72	1.22	Trace of manganese, sodium, and potassium.	98.70	Molding sand, 40–50 mesh.
Nassau County—Roslyn	J. B. King & Co., New York.	Ledoux & Co., New York.	96.65	1.10	1.22	.26	.16	.57		99.96	
Oswego County—Fulton	Fred Pierce Sand Co.	Syracuse University, Syracuse.	84.42	5.12	6.98	.38	.80	2.20		99.90	Molding sand, West Shed, Albany.
Do	do	do	88.50	2.60	2.73	1.68	.82	3.60		99.93	Pierce bed.
Do	do	do	84.64	6.31	1.59	3.22	1.27	2.94		99.97	Fulton bed, Fremont street plant No. 1, fine.
Do	do	do	85.38	5.10	1.94	3.14	1.48	2.94		99.98	Fulton bed, Fremont street plant No. 2, medium.
Do	do	do	81.90	5.69	2.15	4.60	1.01	4.60		99.95	Fulton bed, Fremont street plant No. 3, coarse.
Do	do	do	81.21	10.38	2.62	2.70	.63	2.42		99.96	Core sand from Boonville.
Do	do	do	80.06	5.99	2.00	5.20	1.34	5.20		99.79	Core sand from Sodus Point.
Do	do	do	81.20	10.42	3.64	1.36	.60	2.56		99.78	Molding sand from boiler house shed.
Do	do	do	81.92	3.90	3.50	5.10	Trace.	5.46		99.88	Battle Island bed.
Do	do	do	87.82	4.12	3.70	.60	Trace.	3.66		99.90	Jones bed.
Do	do	do	82.48	2.03	3.65	4.30	1.00	6.50		99.96	Bradford bed.
Do	do	do	81.52	9.40	5.36	1.46	1.71	.48		99.93	Boonville Paragon Plaster Co.
Do	do	do	84.74	5.30	5.56	1.80	1.52	1.00		99.92	Boonville Syracuse Wall Plaster Co.
Rensselaer County—											
Troy	Forbes Manor Realty Co.	James W. Caird, Troy.	87.67	5.81	3.44				Undetermined by difference, 2 per cent. Calcium carbonate ($CaCO_3$), 1.08 per cent.	100.00	Molding sand.
Schenectady County—South Schenectady.	Philip Dutcher & Co.	Department of Agriculture, Albany.	82.00	11.25		.50		2.00		95.75	Do.
OHIO:											
Belmont County—Bellaire	Rosser Sand Co	H. E. Field, Pittsburg, Pa.	84.07	6.96	4.37	Trace.	Trace.			95.40	Do.
Do	do	McIntosh, Hemphill & Co., Pittsburg, Pa.	81.28	8.72	3.43	Trace.	Trace.			93.43	Do.

Analyses of sands quarried in various parts of the United States—Continued.

Location of deposit.	Owner.	Authority.	Silica (SiO_2).	Alumina (Al_2O_3).	Ferric oxide (Fe_2O_3).	Calcium oxide (lime) (CaO).	Magnesium oxide (MgO).	Loss by ignition (mostly water and organic matter).	Other minerals.	Total.	Remarks.
OHIO—Continued.											
Coshocton County—			*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*		*Per ct.*	
Coshocton......	Shoemaker & Casparis, Newcomerstown.	S. V. Peppel, Columbus.	86.86	4.10	3.76	0.82	0.13	4.33	....	100.00	Building sand.
Layland........	Layland Sand and Stone Co.	F. S. Schwab, Chicago, Ill.	98.78	.73	Trace.	.12	.04	.33	Organic matter, 0.33 per cent.	100.00	
Fairfield County—											
Lancaster......	Allegheny Sand Co....	Laboratory Buckeye Steel Castings Co., Columbus.	97.55	1.80		....	....	....	Calcium carbonate ($CaCO_3$), 0.13 per cent. Magnesium carbonate ($MgCO_3$), 0.13 per cent.	99.61	Molding sand.
Sugar Grove....	Sugar Grove Brick Co., Columbus.	Wuth & Stafford, Pittsburg, Pa.	98.43	*a* .85	FeO .72	(*b*)	....	....	....	100.00	
Lucas County—											
Sylvania.......	Toledo Stone and Glass Sand Co.	Operators of quarry...	98.53	.18	.007	....	....	....	Calcium carbonate ($CaCO_3$), 1.20 per cent. Undetermined, 0.083 per cent.	100.00	Glass sand.
Muskingum County—											
Trinway.......	Shoemaker & Casparis, Newcomerstown.	S. V. Peppel, Columbus.	81.81	4.04	5.57	.16	.10	8.32	....	100.00	Building sand.
Portage County—											
Garretsville.....	Portage Silica Co., Youngstown.	R. C. McBride, Youngstown.	98.65	.85		....	....	....	Magnesium carbonate ($MgCO_3$), 0.10 per cent. Calcium carbonate ($CaCO_3$), 0.35 per cent.	99.95	Molding, building, and grinding sand.
Stark County—											
Alliance........	Henry Shaffer........	H. R. Bulmer, Alliance.	89.95	....	8.35	.50	Trace.	....	....	98.80	Molding sand.
Massillon.......	Coxey Silica Sand Co..	Pittsburg Testing Laboratory, Pittsburg, Pa.	96.97	1.83	.31	....	....	.55	....	99.66	Do.
Do.........	The Everhard Co.....	Operators.............	97.50	1.50	.50	....	.50	....	....	100.00	Glass sand prepared for glass.

Do	Massillon Sand and Stone Co.	Otto Wuth, Pittsburg, Pa.	98.611	.123	.033	.130	Trace.			98.897	Do.
Do	Sonnhalter Sand and Stone Co.	John McNamee, Anderson, Ind.	99.60		.02	.23			Clay (?), 0.15 per cent.	100.000	Do.
Summit County—Akron	Franklin Bros	B. F. Goodrich	78.40							78.40	Molding and building sand.
Trumbull County—Niles	National Sand and Stone Co.	Otto Wuth, Pittsburg, Pa.	99.915	.062	.0019	.021	Trace.			99.9999	Glass sand, washed. First grade.
Do	do	Pittsburg Testing Laboratory, Pittsburg, Pa.	98.09	.75	.03	None.	.16	.33		99.36	Glass sand, unwashed. First grade.
Do	do	do	97.10	2.35	.14	.10	Trace.	.31		100.00	Glass sand, unwashed.
Do	do	do	96.46	1.91	1.05	.10	Trace.	.48		100.00	Do.
Tuscarawas County—Dundee	Dundee Silica Sand Co.	F. A. Emmerton, Cleveland.	99.60							99.60	No. 1 sand; glass sand.
Do	do	do	98.87							98.87	No. 2 sand.
Do	do	do	98.63							98.63	No. 3 sand.
Do	do	do	95.30							95.30	Open-hearth sand.
Do	F. W. Meyer	do	98.45	.77	.14					99.36	
Do	Beach City Silica Sand Co.	do	98.43		.25	None.	.08		Manganese oxide (MnO); phosphorus (P); sulphur (S), none.	98.76	
Strasburg	P. Arnold	Otto Wuth, Pittsburg, Pa.	98.80	1.17	.034	Trace.	Trace.			100.004	Molding sand.
PENNSYLVANIA:											
Blair County—Williamsburg	W. W. Cronister, Altoona.	Pittsburg Testing Laboratory, Pittsburg.	98.35	.95	.50	None.	Trace.	.20		100.00	
Butler County—Cabot	New Kensington Stone Co., Wilkinsburg.	do	97.40	1.91	.29	Trace.	None.			99.60	Molding sand.
Carbon County—Bowmanstown.	Blue Ridge Sand Co., Slatington.	H. M. Ullman	98.00	.33		None.	None.	.64		98.97	Molding.
Hazard (near Aquashicola).	Hodgson Sand Co.	T. A. J. Hodgson	97.30	1.50	1.20					100.00	Molding and building.
Chester County—Exton	Whiteland Silica Co., Lockport, N. Y.	H. C. Harrison	98.98							98.98	
Clarion County—Foxburg	Foxburg Sand and Stone Co., Pittsburg.	Gulick & Henderson, Pittsburg.	98.06	.32	.74	.06	.02			99.20	Glass sand.
Cumberland County—Mount Holly Springs.	H. C. Gill		98.80	.34	.50	.31	.05			100.00	Building sand.
Do			98.57	.92	.40	.04	.07			100.00	

a Includes calcium oxide.

b Included with alumina.

Analyses of sands quarried in various parts of the United States—Continued.

Location of deposit.	Owner.	Authority.	Silica (SiO_2).	Alumina (Al_2O_3).	Ferric oxide (Fe_2O_3).	Calcium oxide (lime) (CaO).	Magnesium oxide (MgO).	Loss by ignition (mostly water and organic matter).	Other minerals.	Total.	Remarks.
PENNSYLVANIA—Continued.											
Elk County—			*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*		*Per ct.*	
Ridgway	Croyland Silica Sand Co.	Pittsburg Testing Laboratory, Pittsburg.	98.50	0.60	0.50	0.75	0.30			100.65	Grinding glass.
Do	The Fox Sand Co.		98.69							98.69	Glass sand.
Do	Ridgway Sandstone Co.	International Text Book Co., Pittsburg.	98.55	1.22	.21	Trace.	Trace.			99.98	Glass sand, molding sand, etc.
Erie County—											
West Springfield.	Buffalo Sand Co., Buffalo, N. Y.		98.40							98.40	Molding sand.
Do	do		92.20			3.80			(?) 0.40 per cent	96.40	Building sand.
Huntingdon County—											
Mapleton Depot	Juniata White Sand Co.	Otto Wuth, Pittsburg.	99.85	.14	.012	Trace.				100.02	Glass sand.
Do	Pennsylvania Glass Sand Co.	Booth, Garrett & Blair, Philadelphia.	99.70	.24	.026	Trace.	Trace.			99.966	Do.
Do	Pittsburg White Sand Co., Lewistown.	Laboratory, Pennsylvania State College, Philadelphia.	99.65	.09		.26				100.00	Do.
Markleysburg (near Aitch).	Standard Sand Co., Altoona.	C. B. Dudley, Chemist P. R. R. Co.	98.70	.81		Trace.	None.	0.49		100.00	Do.
Mill Creek	Pennsylvania Glass Sand Co., Lewistown.	Booth, Garrett & Blair, Philadelphia.	99.72	.25	.014	Trace.	Trace.			99.984	Do
Do	do	do	99.83	.12	.01	.04				100.00	Do.
Do	Westbrook Glass Sand Co., Tyrone.	M. L. Cressman, Lewistown.	99.00	.20	Trace.	.40	.40			100.00	Do
Jefferson County—											
(near Falls Creek, Clearfield Co.).	Crystal Window Glass Co.	Otto Wuth, Pittsburg.	99.410	.551	.029	.101	Trace.			100.091	Do.
Lancaster County—											
Honey Brook (near Lancaster).	Diller Sand and Clay Co., Lancaster.	H. C. Deming, Harrisburg.	98.111	.961	FeO .252	.09	.02	.338	Potassium and sodium oxides (K_2O and Na_2O), 0.10; sulphur (S), 0.0018; phosphoric anhydride (P_2O_5), 0.006 per cent.	99.8798	Building, fire, and furnace sand.

Do	do	do	98.387	1.090	FeO.368	.073	.045	.285	Potassium and sodium oxides (K_2O and Na_2O), 0.315; sulphur (S), 0.0012; phosphoric anhydride (P_2O_5), 0.0021 per cent.	100.5663	
Landisville	J. M. Trout	Laboratory, Franklin Marshall College, Lancaster.	96.47	2.87		.12	.22	.32		100.00	
Lycoming County—Linden	D. N. Thomas, Williamsport.	Laboratory, Pennsylvania State College.	95.44		1.46				Other oxides, 3.10 per ct.	100.00	Molding sand.
McKean County—Sergeant Station (near Burrows).	Sergeant Glass Co., Burrows.	Wm. L. Heim	98.42	.80	.27	.14	.12	.25		100.00	Washed glass sand.
Mercer County—Greenville	Greenville Sand and Supply Co.	Henry C Deming, Harrisburg.	91.22	2.19	3.72	.38	.02	1.31	P_2O_5 0.0149; Na_2O K_2O 0.59; S 0.0028	99.4477	Molding and building sand.
Do	do	do	85.06	8.32	3.09	.39	.03	1.89	.0018; 1.12; .0023	99.9041	Do.
Do	do	do	89.99	3.61	2.24	.47	.45	1.67	.0155; 1.16; .0004	99.6059	Do.
Do	do	do	87.98	4.29	2.19	1.77	.29	2.28	.0265; .42; .0104	100.2569	Do.
Do	do	do	95.63	.72	.59	.13		.20	.0003; 1.20; 1.26	99.7303	Do.
Do	Greenville Silica Sand and Quarry Co.	Otto Wuth, Pittsburg.	99.822	.156	.02	.0036				100.0016	Sand from rock, average of ten samples.
Leesburg (near Mercer).	The Mercer Sand Co., Mercer.		96.60	2.50	1.01	.05			Phosphorus (P) Trace	100.16	Molding and furnace sand.
Montgomery County—Edge Hill	Edge Hill Silica Rock Co., New Brunswick, N. J.	Geo. C. Davis, Philadelphia.	95.49	1.74	.38	Trace.	.39	.58		98.58	Fire sand.
Oreland	Springfield Sands, Enfield.		69.38	17.45	1.52	.65	1.01	4.77	Sodium oxide (Na_2O) 0.60; Potassium oxide (K_2O,) 3.78; Manganese oxide (MnO), 1.02 per cent.	100.18	Mica schist sand.
Spring Mill (near William Penn).	Wm. Penn Silica Wks., William Penn.	J. Westesson, Philadelphia.	93.49	4.23	.77	.57	Trace.			99.06	Molding and fire sand.
Philadelphia County—Philadelphia		Frank R. Smith	96.38	3.28		.25	.09			100.00	Sand dredged from Delaware River.
Venango County—Carlton (near Franklin).	Dick Sand Co., Franklin.		97.36	1.54		None.	None.	.65		99.55	Molding sand.
Kennerdell	Kennerdell Sand and Manufacturing Co., Pittsburg.	G. P. Maury, The Metallurgical Laboratory, Pittsburg.	99.25	.60		Trace.	Trace.	.20		100.05	Glass sand.
Utica	Franklin Silica Sand Co., Franklin.		97.72	.34	.98	None.	None.	.72		99.76	Molding sand.

Analyses of sands quarried in various parts of the United States—Continued.

Location of deposit.	Owner.	Authority.	Silica (SiO_2).	Alumina (Al_2O_3).	Ferric oxide (Fe_2O_3).	Calcium oxide (lime) (CaO).	Magnesium oxide (MgO).	Loss by ignition (mostly water and organic matter).	Other minerals.	Total.	Remarks.
PENNSYLVANIA—Continued.											
Warren County—			*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*		*Per ct.*	
Torpedo	The White Silica Sand and Cement Brick Co., Erie.	Erie Laboratory, Erie.	98.69	0.64	0.34	0.06	Trace.	0.25		99.98	Yellow sample, unwashed and unscreened.
Do	do	do	99.02	.58	.14	Trace.	Trace.	.23		99.97	White sample, unwashed and unscreened.
Westmoreland County—											
Derry	American Window Glass Co., Pittsburg.	Engineers and Founders Laboratory, Pittsburg.	99.25	.25	.06	.05		.38		99.99	Glass sand, washed.
Do	do	Otto Wuth, Pittsburg.	98.76	.932	.054	.183	0.071			100.00	Glass sand.
Do	Derry Glass Sand Co., Latrobe.	E. S. Brown, Latrobe.	99.65	.17	.11	.02	.03			99.98	Do.
Donohue (near Latrobe).	Unity Sand and Stone Co., Greensburg.	W. F. Elwood, Greensburg.	85.88	.802 (alumina and ferric oxide)		1.00	2.92	2.48		100.30	Building sand.
Seward (near)		A. J. Phillips	97.54	.81	.09	1.04	.06	.52	Sodium oxide (Na_2O), 0.02; Potassium oxide (K_2O,) 0.16; Sulphuric anhydride (SO_3), trace.	100.24	Glass sand from Pottsville formation.
TENNESSEE:											
Bradley County—											
Black Fox	Black Fox Silica Mining Co., Cleveland.	C. M. Clark, Chattanooga.	98.97	0.79 (alumina and ferric oxide)						99.76	
Hardeman County—											
Saulsbury	Durden Sand Co	Foster Laboratory, Sheffield, Ala.	92.70	.26	3.30	Trace.		.15		96.41	Glass sand.
Do	do	do	94.90	.17	2.40	Trace.		.25		97.72	Do.
Do	do	do	91.00	.23	3.50	Trace.		.75		95.48	
TEXAS:											
Lampasas County—											
Lampasas	F. J. Harris	Regis Chauvenet & Bro., St. Louis, Mo.	94.26		5.74 (ferric oxide, calcium oxide and magnesium oxide)					100.00	
UTAH:											
Salt Lake County—											
Near Salt Lake City.	Crystal Lime and Cement Co.	F. M. Bishop	99.00	.10	Trace.				Calcium carbonate ($CaCO_3$), 0.40 per cent.	99.50	

Princess Anne County—Cape Henry	Norfolk and Southern Railway Co.		95.00						Trace	95.00	
Roanoke County—Salem	Catawba Valley Railway Mining Co.	C. N. Sanders	99.04	.28	.70					99.74	Do.
Do	Cooper Glass and Silica Co.	W. L. Watts, West End Furnace, Roanoke.	98.80	.28	.11	Trace.	Trace.	.60	Trace of alkalies	99.79	Do.
Do	do	Froehling & Robertson, Richmond.	97.18	1.38	.28	.18	.11	.44	Potassium oxide (K_2O), 0.21; sodium oxide (Na_2O), 0.20 per cent.	99.98	Do.
WEST VIRGINIA:											
Hampshire County—Green Spring	Potomac White Sand Co., Cumberland, Md.	F. T. Ashman Co., Pittsburg, Pa.	99.19		.56					99.75	Do.
Marshall County—Moundsville	Chestnut Hill Sand and Coal Co.	Pittsburg Testing Laboratory, Pittsburg, Pa.	86.06	5.70	2.14	1.40	.29	2.16		97.75	Building sand.
Monongalia County—Sturgisson	Decker Creek Stone and Sand Co.	Laboratory, West Virginia Experiment Station.	99.55		.33			.11		99.99	Glass sand.
Star City	R. B. Reid	C. S. Howard, University of West Virginia.	99.04	.60	.12	Trace.	.04	.20		100.00	Dried at 110°, white sample.
Do	do	do	98.40	.54	.41	.04	.21	.40		100.00	Dried at 110°, reddish sample.
Morgan County—Berkeley Springs.	Berkeley Sand Co.	Pittsburg Testing Laboratory, Pittsburg, Pa.	99.37	.33	.04			.17	Cobalt (Co), none	99.91	Glass sand.
Do	Speer White Sand Co.	Otto Wuth, Pittsburg, Pa.	99.701	.291	.008	Trace.	Trace.			100.00	Do.
Do	West Virginia and Pittsburg Sand Co.		99.89	.105	.005	Trace.				100.00	Do.
(Near) Hancock, Md.	Pennsylvania Glass Sand Co., Lewistown, Pa.	Otto Wuth, Pittsburg, Pa.	99.889	.094	.006	.011				100.00	Do.
Preston County—Corinth	Corinthian White Sand Co.		99.936	.043	FeO.021	Trace.	Trace.			100.00	Do.
Independence	Irvington Mineral Co.	National Canners Laboratory, Aspinwall, Pa.	99.73		.06					99.79	Do.

Analyses of sands quarried in various parts of the United States—Continued.

Location of deposit.	Owner.	Authority.	Silica (SiO_2).	Alumina (Al_2O_3).	Ferric oxide (Fe_2O_3).	Calcium oxide (lime) (CaO).	Magnesium oxide (MgO).	Loss by ignition (mostly water and organic matter).	Other minerals.	Total.	Remarks.
WEST VIRGINIA—Continued.											
Randolph County—			*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*		*Per ct.*	
Silica	Enterprise Silica Sand Co., Bellaire, Ohio.	Wheeling Steel and Iron Works, Wheeling.	98.75							98.75	Glass sand.
Do	do	do	99.12	0.28	0.33			0.27		100.00	
Do	do	Carnegie Steel Co., Bellaire, Ohio.	96.00	1.30	.75		0.40	.75	Potassium oxide (K_2O), sodium oxide (Na_2O), 0.80.	100.00	
Upshur County—											
Craddock	Silica Sand Co	Laboratory, National Tube Co.	99.38	.38	.13	0.005	Trace.			99.895	
Do	do	Laboratory, Carnegie Steel Co.	99.46	.15	.25	.14				100.00	
Do	do	do	99.38		.26	.36				100.00	
WISCONSIN:											
Columbia County—											
Portage	Columbia Silica Co	A. S. Mitchell, Milwaukee.	99.20	.57	.02	.21				100.00	Do.
Grant County—											
Boscobel		George Steiger, U. S. Geological Survey.	99.47		.07					99.54	Do.
Flora (near Lancaster).		do	99.17	.25	.22					99.64	Do.

IMPORTS.

Sand valued at $106,234 was imported into the United States in 1909, as compared with imports valued at $77,574 in 1908, $94,871 in 1907, and $85,566 in 1906.

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LIME.

By Ernest F. Burchard.

PRODUCTION.

The lime industry showed a satisfactory gain in 1909, both in tonnage and in value of products over the production of 1907, the next preceding normal business year. As compared with 1908 the quantity of lime manufactured increased from 2,766,873 short tons to 3,472,852 short tons, or more than 25.5 per cent. The value of the production in 1909 was $13,805,405, as compared with $11,091,186 in 1908, an increase of more than 24 per cent, or nearly the same ratio of increase as for the quantity. The average price per ton decreased from $4.01 in 1908 to $3.98 in 1909, about 0.75 per cent. The number of producers increased from 949 in 1908 to 1,232 in 1909. Many of these producers are farmers in Pennsylvania who do not operate on a commercial scale but merely burn a kiln or two of lime occasionally for agricultural purposes. Pennsylvania, as usual, ranked first in quantity and value of lime output as well as in number of producers. Fully 25 per cent of the total output for the United States in 1909 was burned in Pennsylvania. In 1908, 42 States reported production; in 1909, 44 States (including Hawaii and Porto Rico) produced lime; and in about two-thirds of them the production increased over that of 1908.

The statistics of the production of lime for 1909 have been collected by the United States Geological Survey in cooperation with the Bureau of the Census, and the securing of the replies to the numerous and detailed inquiries contained in the general census schedule has delayed the publication of the statistics far beyond the time at which the Geological Survey usually presents them to the public.

In addition to the figures of production already given the Bureau of the Census reports that 24,352 short tons of lime, valued at $78,405, or at about $3.22 per ton, were produced from oyster shells. This output, which may be considered as a by-product of the oyster canning industry rather than a product of mineral industry, came from small kilns established at Suffolk, Va., Baltimore, Md., Camden and Newark, N. J., and Scranton, Pa. The fuel used for burning this lime was mainly screenings from anthracite coal, although at least one firm reported the use of bituminous coal. The uses of the product, a high-calcium quicklime, were variously reported, the greater part being used as agricultural lime, and smaller quantities for glass making and for making "Venetian red."

The following table gives the value of the total lime production in the United States for the years 1898 to 1909, inclusive:

Value of lime produced in the United States, 1898–1909.

1898	$6,886,549	1904	$9,951,456
1899	6,983,067	1905	10,941,680
1900	6,797,496	1906	12,480,653
1901	8,204,054	1907	12,656,705
1902	9,335,618	1908	11,091,186
1903	9,255,882	1909	13,805,405

Detailed statistics of the production of lime in 1908 and 1909 are given in the following table:

Quantity and value of lime burned in the United States in 1908 and 1909, by States, in short tons.

1908.

Rank of State.	State.	Quantity.	Value.	Average price per ton.	Number of operators.
11	Alabama	83,411	$335,234	$4.02	13
26	Arizona	10,819	68,635	6.33	3
22	Arkansas	27,179	122,290	4.50	9
6	California	70,913	581,481	8.20	17
35	Colorado	5,615	28,179	5.02	3
12	Connecticut	62,070	307,895	4.96	6
28	Florida	11,822	62,915	5.32	3
30	Georgia	11,193	46,780	4.18	6
29	Idaho	7,373	57,020	7.73	5
10	Illinois	92,549	393,951	4.26	18
13	Indiana	95,988	293,579	3.06	12
24	Iowa	18,900	79,400	4.03	6
41	Kansas	1,558	8,086	5.19	4
37	Kentucky	6,206	21,322	3.44	8
5	Maine	141,934	661,453	4.66	6
14	Maryland	103,224	292,623	2.83	41
7	Massachusetts	107,813	566,022	5.25	10
15	Michigan	68,050	282,023	4.14	10
23	Minnesota	19,800	85,700	4.33	4
4	Missouri	167,060	701,321	4.20	28
32	Montana	5,121	32,981	6.44	6
21	New Jersey	32,700	134,722	4.12	21
8	New York	106,025	529,501	4.99	36
36	North Carolina	5,132	24,750	4.82	5
2	Ohio	279,080	975,661	3.50	34
34	Oregon	3,274	28,795	8.80	8
1	Pennsylvania	582,352	1,883,496	3.23	443
31	South Dakota	5,254	34,068	6.48	5
17	Tennessee	73,016	226,463	3.10	17
20	Texas	33,725	144,118	4.24	8
25	Utah	12,237	78,346	6.40	11
19	Vermont	32,691	170,205	5.21	10
9	Virginia	107,209	424,374	3.96	29
16	Washington	32,343	228,353	7.06	9
18	West Virginia	91,747	202,664	2.21	41
3	Wisconsin	235,538	831,792	3.53	44
42	Wyoming	392	4,246	10.83	4
27	Hawaii			9.00	
39	Nevada			13.00	
40	New Mexico	15,560	140,742	6.43	6
38	Rhode Island			7.11	
33	South Carolina			5.17	
	Total	2,766,873	11,091,186	4.01	949

Quantity and value of lime burned in the United States in 1908 and 1909, by States, in short tons—Continued.

1909.

Rank of State.	State.	Quantity.	Value.	Average price per ton.	Number of operators.
15	Alabama	75,268	$290,059	$3.85	16
25	Arizona	12,473	84,223	6.75	4
23	Arkansas	28,065	133,025	4.74	9
9	California	62,942	528,373	8.39	16
36	Colorado	5,024	26,935	5.36	4
11	Connecticut	83,096	405,545	4.88	7
28	Florida	11,558	50,569	4.38	3
29	Georgia	11,903	44,962	3.78	6
27	Idaho	12,631	81,463	6.45	8
10	Illinois	104,260	454,682	4.36	17
14	Indiana	99,325	335,154	3.37	11
26	Iowa	15,739	82,202	5.22	5
42	Kansas	1,332	8,018	6.02	5
40	Kentucky	4,331	13,741	3.17	10
4	Maine	178,564	957,690	5.36	9
12	Maryland	125,436	367,945	2.93	43
6	Massachusetts	136,546	709,128	5.19	8
13	Michigan	83,108	354,135	4.26	12
20	Minnesota	43,841	215,568	4.92	8
5	Missouri	182,460	815,367	4.47	27
35	Montana	4,540	27,713	6.10	5
22	New Jersey	38,014	146,401	3.85	21
39	New Mexico	2,640	14,200	5.38	5
8	New York	124,594	542,274	4.35	35
30	North Carolina	9,881	44,148	4.47	7
2	Ohio	343,754	1,241,719	3.61	33
34	Oregon	3,205	29,305	9.14	7
1	Pennsylvania	885,239	2,542,954	2.87	635
38	Porto Rico	3,329	17,277	5.19	29
33	South Dakota	5,309	35,982	6.78	5
18	Tennessee	78,620	245,724	3.13	21
19	Texas	53,578	244,845	4.57	13
24	Utah	16,388	116,992	7.14	15
21	Vermont	42,369	209,941	4.96	11
7	Virginia	164,695	627,946	3.81	48
16	Washington	39,270	282,628	7.20	12
17	West Virginia	89,569	279,263	3.12	46
3	Wisconsin	268,250	1,067,500	3.98	46
44	Wyoming	226	2,756	12.19	3
37	Hawaii			8.71	
43	Nevada			13.00	
41	Oklahoma	21,480	127,053	4.53	6
31	Rhode Island			4.46	
32	South Carolina			6.77	
	Total	3,472,852	13,805,405	3.98	1,231

USES OF THE LIME PRODUCED.

Few mineral products have so wide a variety of uses as lime. A little more than half the lime manufactured in the United States is used as a structural material, and the remainder, amounting to more than 1,250,000 tons, valued at about $5,250,000, is used for chemical purposes. The principal uses which lime has in building operations are in lime mortars and plasters, in gaging Portland cement mortars, concrete, and gypsum plasters, and as a whitewash. Both quick and hydrated lime are used in building operations.

The limes most commonly used fall into the following three general divisions, depending on the chemical composition: (1) High calcium lime, containing 90 per cent or more of calcium oxide (CaO); (2) magnesian limes, containing 5 to 25 per cent magnesia (MgO) the remainder consisting essentially of calcium oxide; (3) high magnesian to dolomitic limes, containing 25 to 45 per cent magnesia, the remainder consisting essentially of calcium oxide. Recent tests have indicated that the magnesian limes are generally best suited to structural work and high calcium limes to chemical purposes, but for certain uses the reverse of this rule is true, and for many applications in each branch of industry either type of lime is equally well suited.

The chemical uses of lime are much more varied than the uses of lime in building. A number of the industries that are large users of lime are listed below, together with the special purposes served by lime in each industry and the kind of lime most suitable to such purposes.

Chemical uses of lime.[a]

Agricultural industry:
- As a soil amendment, c, m.
- As an insecticide, c, m.
- As a fungicide, c, m.

Bleaching industry:
- Manufacture of bleaching powder, "Chloride of lime," c.
- Bleaching and renovating of rags, jute, ramie, and various paper stocks, c, m.

Caustic alkali industry:
- Manufacture of soda, potash, and ammonia, c.

Chemical manufacture:
- Manufacture of potassium dichromate and sodium dichromate, c.
- Manufacture of magnesia, m.
- Manufacture of acetate of lime, c.
- Manufacture of wood alcohol, c.
- Manufacture of bone ash, c, m.
- Manufacture of calcium carbides, c.
- Manufacture of calcium light pencils, c.
- In refining mercury, c.
- In dehydrating alcohol, c.

Gas manufacture:
- Purification of coal gas and water gas, c, m.

Glass manufacture:
- Most varieties of glass, c, m.

Milling industry:
- Clarifying grain, c, m.

Miscellaneous manufactures:
- Rubber, c, m.
- Glue, c, m.
- Pottery and glazing, c.
- Dyeing fabrics, c, m.

Miscellaneous manufactures—Contd.
- Polishing material, c, m.

Oil, fat, and soap manufacture:
- Manufacture of soap, c.
- Manufacture of glycerine, c.
- Manufacture of candles, c.
- Renovating fats, greases, tallow, butter, c, m.
- Removing the acidity of oils and petroleum, c, m.
- Lubricating greases, c, m.

Paint and varnish manufacture:
- Cold water paint, c, m.
- Refining linseed oil, c, m.
- Manufacture of linoleum, c, m.
- Manufacture of varnish, c, m.

Paper industry:
- Soda method, c.
- Sulphite method, m.
- For strawboard, c, m.
- As a filler, c, m.

Preserving industry:
- Preserving eggs, c.

Sanitation:
- As a disinfectant and deodorizer, c.
- Purification of water for cities, c.
- Purification of sewage, c.

Smelting industry:
- Reduction of iron ores, c, m.

Sugar manufacture:
- Beet root, c.
- Molasses, c.

Tanning industry:
- Tanning cowhides, c.
- Tanning goat and kid hides, c, m.

Water-softening industry, c.

The table following gives the total lime marketed in 1908 and 1909 classified according to its consumption in certain general industries as reported by the producers. As much of the product is handled by dealers or middlemen, the manufacturers are uncertain as to what use was made of their product and this table is therefore necessarily faulty, but it is of interest as showing a comparative table of sales for the two years. Each manufacturer, as a rule, classifies his output similarly from year to year.

[a] High calcium lime is indicated by c: magnesian and dolomitic lime by m.

Production of lime in the United States in 1908 and 1909, by uses, in short tons.

1908.

	Quantity.	Value.	Average price per ton.
Building lime	1,580,590	$7,000,904	$4.43
Hydrated lime	136,441	548,262	4.02
Alkali works	46,384	203,658	4.39
Chemical works	73,119	259,190	3.54
Paper mills	169,831	540,559	3.18
Sugar factories	24,255	149,631	6.17
Tanneries	22,684	92,873	4.09
Fertilizer	339,287	927,827	2.73
Dealers—uses not specified	307,050	1,100,129	3.58
Other uses [a]	67,232	268,153	3.99
Total	2,766,873	11,091,186	4.01

1909.

	Quantity.	Value.	Average price per ton.
Building lime	1,904,863	$8,390,553	$4.41
Alkali works	12,820	39,586	3.09
Chemical works	156,307	535,887	3.43
Paper mills	274,912	971,895	3.54
Sugar factories	13,787	55,079	3.99
Tanneries	72,899	292,258	4.01
Fertilizer	595,517	1,630,653	2.74
Dealers—uses not specified	321,530	1,414,919	4.40
Other uses [a]	120,217	474,575	3.95
Total	3,472,852	13,805,405	3.98
Hydrated lime, included in total	207,611	913,150	4.40

[a] Includes lime for sand-lime brick, slag cement, steel works, glass works, smelters, sheep dipping, disinfectant, manufacture of soap, cyanide plants, glue factories, etc.

FUELS USED IN BURNING LIME.

With regard to the following table, which shows the fuels used in burning lime, it must be remembered that only about two-thirds of the producers report the quantity of fuel used by them:

Kind and quantity of fuel used in burning lime in 1908 and 1909.

1908.

Kind of fuel used.	Quantity of fuel.	Quantity of lime burned.	Number of plants using.
Wood ... cords	325,943	638,092	194
Coal ... short tons	295,333	871,490	413
Coke ... do	5,118	29,018	8
Oil ... barrels	23,804	15,269	8
Gas ... cubic feet	288,385,512	110,738	12
Mixed fuels:			
Wood ... cords	77,957	449,837	76
Coal ... short tons	97,287		
Coal and coke ... do	9,157	35,700	6
Coal ... do	5,000	30,130	2
Gas ... cubic feet	141,666,000		
Oil and wood, wood and coke, blocks, sawdust, shavings	....	29,993	5
Total	....	2,210,267	724
Unreported	....	556,606	225
	....	2,766,873	949

Kind and quantity of fuel used in burning lime in 1908 and 1909—Continued.

1909.

	Quantity.	Value.	Number of plants using.
Wood .... cords..	256,692	$483,321	190
Coal .... short tons..	392,725	1,152,502	511
Coke .... do....	6,109	26,409	14
Oil .... barrels..	20,518	12,566	5
Gas .... cubic feet..	1,219,656,000	73,258	8
Mixed fuels:			
Wood .... cords..	172,165	851,611	192
Coal .... short tons..	163,195		
Coal .... do....	6,512	37,945	16
Coke .... do....	11,898		
Wood .... cords..	5,900	106,122	7
Coal .... short tons..	14,655		
Coke .... do....	16,870		
Wood, coal and oil; coal and coke, wood and oil; wood and shavings; wood and coke; manure, shavings and slabs; wood, coal and gas; coal and gas; wood, coal, coke and gasoline	....	124,473	20
Total	....	2,868,207	964
Unreported	....	604,645	268
	....	3,472,852	1,231

The total quantity of the various kinds of fuel consumed in the domestic lime industry during 1908 and 1909 was, therefore, as follows:

Total fuel consumed in burning lime in 1908 and 1909.

	1908.	1909.		1908.	1909.
Wood .... cords..	409,805	450,986	Coke .... short tons..	5,268	38,271
Shavings.... short tons..	5,800	600	Gas .... cubic feet..	430,051,512	1,336,486,000
Coal .... do....	397,620	584,412	Oil .... barrels..	23,884	50,324

HYDRATED LIME.

When quicklime is slaked, by whatever process, whether in the simple mortar box by adding water by the bucketful and stirring with a hoe, or whether the lime and water are automatically weighed out in definite parts and the mass stirred by machinery, the chemical principle involved is the same, viz, quicklime plus water equals slaked lime, or hydrated lime—

$$CaO + H_2O = Ca(OH)_2,$$

or, if the limestone used for making quicklime contains magnesia, the following equation is appropriate: Magnesian quicklime plus water equals slaked or hydrated magnesian lime—

$$CaO.MgO + H_2O = Ca(OH)_2.MgO.$$

Commercially the term "hydrated lime" is restricted to the dry powder prepared by treating quicklime with just enough water to combine with all the calcium oxide or calcium and magnesium oxides present. In the preparation of hydrated lime two materials only are used—fresh caustic lime and water. The general method of preparation is first to reduce the lumps of lime by crushing to about $\frac{1}{2}$-inch size. In some plants this reduction is carried further by grinding the lime to about the fineness of granulated sugar. The crushed or granulated lime is then treated with sufficient water to combine chemically with the calcium oxide in the lime, care being taken that the quantity is neither too little to satisfy the chemical requirements nor so great as to leave the hydrated mass wet or even damp. In practice, an excess of water is used, but this excess is driven off by the heat generated in the slaking or hydrating of the lime. The three different methods of manufacture most extensively employed in this country are the Clyde, the Kritzer, and the Reaney methods, each method taking its name from the type of machinery used.

Hydrated lime is used both as a structural material and in many of the industries. It is very conveniently handled, as it is ordinarily shipped in either cloth or paper sacks. The production for each of the last four years was as follows: 1906, 120,357 short tons, valued at $479,079; 1907, 140,135 tons, valued at $657,636; 1908, 136,441 tons, valued at $548,262, and 1909, 207,611 tons, valued at $913,150. The average value per ton was $3.98 in 1906, $4.69 in 1907, $4.02 in 1908, and $4.40 in 1909.

The following table shows the number of lime hydrating plants reported to the Survey as operating in the United States during the last four years, and draws attention to the steady development of this phase of the lime industry:

Number of lime-hydrating plants in operation in 1906, 1907, 1908, and 1909, by States.

State.	1906.	1907.	1908.	1909.	State.	1906.	1907.	1908.	1909.
Alabama	1	1	1	3	Michigan	1	1	2	1
Arizona	1	1	1	1	Missouri		2	2	3
California		1	2	2	New Jersey			1	1
Colorado		1		1	New York	1	2	2	3
Connecticut	1			1	Ohio	8	9	11	8
Florida			1		Pennsylvania	8	6	11	10
Georgia	2	1	1		Tennessee			1	1
Idaho				1	Texas			1	3
Illinois		1	1	2	Virginia			1	2
Indiana	2	2	2	2	West Virginia	1	1	1	
Iowa	1			1	Wisconsin	1	2	2	2
Kansas	1	1		1					
Maine	1	1	1	1	Total	30	33	46	51
Maryland			1	1					

IMPORTS AND EXPORTS.

The imports of lime for consumption in the United States in 1909 were 8,687 short tons, valued at $75,556, as against 5,060 short tons, valued at $28,952, in 1908—an increase of 3,627 short tons in quantity and of $46,604 in value in 1909.

No lime was reported as exported in 1908 nor in 1909. In 1907 the exports were valued at $90,379.

SAND-LIME BRICK.

By Jefferson Middleton.

INTRODUCTION.

GENERAL CONDITION OF INDUSTRY.

The sand-lime brick industry has developed rapidly in the United States. It began in 1901 at Michigan City, Ind., with one plant producing only a few thousand brick, which was followed shortly by a plant at Wilmington, N. C. In 1903 there were 16 plants in operation, which marketed a product valued at $155,040. From this small beginning the number of operating plants and the value of the product increased steadily until 1907, when 94 operating plants reported an output valued at $1,225,769. These figures are the highest yet recorded in the industry. In common with other industries, the value of sand-lime brick fell off considerably in 1908. In 1909, however, there was a small increase, and 1910 bids fair to exceed the record of 1907. There appears to be no doubt that this industry is firmly established and will probably show a steady growth. The experimental stages have been passed, and although, as in all lines of endeavor, there will be individual failures, it is believed that the problems of the successful manufacture of sand-lime products of high grade have been solved and that with proper material and manipulation a good product can be made. Where material is abundant and the market satisfactory, especially if there be an absence or scarcity of other structural material, the sand-lime brick industry should prosper. This product has been subjected to many tests, both in the laboratory and in actual use, and seems to have met these tests in a generally satisfactory manner.

The organization some years ago of an association of the manufacturers of sand-lime products for the improvement of the products and the betterment of trade conditions appears to have had a beneficial effect.

SAND-LIME BRICK IN GERMANY.

A statement concerning the present status of the industry in Germany, where the process of making sand-lime products originated, may be of interest, and a report by Consul-General Robert P. Skinner, Hamburg, on sand-lime bricks in Germany[a] is as follows:

[a] Daily Cons. and Trade Repts., No. 9, January 12, 1911, issued by the Bureau of Manufactures, Department of Commerce and Labor.

The manufacture of sand-lime bricks (called "Kalksandsteine" in Germany) has assumed large proportions in the last few years, and the great improvements effected in processes of manufacture amply justify the adoption of this building material in the United States. From 1897 to 1902 alone 80 plants were established in Germany for the production of these bricks, and there are now said to be 280 in operation. Hamburg firms producing kalksandsteine are satisfied with the business results.

Ordinary sand-lime bricks sell at an average price of 2 marks ($0.476) less per 1,000 than clay bricks. The cost of production is said to be 9 to 12 marks ($2.142 to $2.856) per 1,000, but it is difficult to generalize on this, as no two localities are situated alike as to raw materials. In 1902 the German Reichstag purchased 9,000,000 bricks of this kind, made by the Schwartz process, for army buildings at a saving of $20,000 over clay bricks.

Original method of manufacture.—The elementary facts in the brick business are that clay does not exist everywhere, whereas sand is found almost everywhere and can be used at a lower cost. The processes of manufacturing sand-lime bricks are numerous, some being protected by patents. The original method of manufacture was as follows:

Fat lime slaked to a thick milk is mixed with six to twelve times its own quantity of coarse sand and then carefully kneaded either by hand or in a mixing machine. Bricks are then formed in an ordinary clay press, and after twenty-four hours, being then slightly dry, are stacked together and assume sufficient hardness after three to four weeks. The hardening process is accelerated by dipping the slightly dry bricks in a very thin solution of silicate of potash.

Thus a very cheap material can be produced for agricultural buildings where lime and good sand are available. The bricks are frost proof and rather compact, and no extensive machinery is required. Sand-lime bricks produced upon an industrial scale are the pressed product of a complete mixture of lime and sand hardened [molded?] under steam pressure of an average minimum compressive strength of 140 kilos per square centimeter (308.64 pounds per 0.155 square inch). This mortar contains 5 to 8 per cent of lime, and upon being pressed into bricks—which are then exposed to a steam pressure, usually under 72 [7.2?] atmospheres during eight to ten hours—the bricks can be used at once.

Increasing success of this type.—The foregoing process is based upon the discovery, in 1880, of Doctor Michaelisin, that salicylic acid can be decomposed, that is to say, can be caused to form hydrated silicate of lime by chemical combination with lime from hydrate of lime only in a very high temperature and in the presence of steam. This high-pressure process has been developed in Germany since 1898, and it is believed that from eight hundred million to one thousand million bricks of this kind are being manufactured annually. Bricks of this kind are rivaling clay bricks with increasing success, their adoption being furthered by the facts (1) that an extraordinarily small quantity of lime is necessary, since the poorest mortar requires more sand than lime; (2) that sand can be found almost everywhere; (3) that the time required to manufacture is short and the general expenses are low; (4) that the bricks can be manufactured at all seasons of the year.

Fat lime is used ordinarily in the manufacture of these bricks and hydraulic lime very seldom. Dolomitic lime, which slakes slowly, is not available. Any kind of quartz sand which is free from clay and not too coarse can be used.

Variations in compotent elements.—The various processes are distinguished from each other by the method of treating the lime. In some the lime is completely slaked to powder or paste before being mixed with the sand, this being the ordinary hydrate process. Elsewhere the lime is ground to powder (quicklime powder), then mixed with sand, and then slaked. The hardening of the bricks is always done in the same manner—in a hardening boiler. According to the first, or hydrate, process, the mixed material remains at first amorphous, and then gradually becomes crystalline; whereas in the quicklime process the mixture assumes a crystalline form immediately, which is said to be why the bricks possess a greater solidity from the beginning. However, it is alleged that the quicklime process requires a larger dose of lime, and that the completed bricks are too dense, thus absorbing less water and allowing the passage of less air.

According to Burchartz, there is no material difference between the several kinds of sand-lime bricks as regards density and water absorpton, and all kinds of sand-lime bricks increase in compactness within certain limits.

In the pure hydrate process the lime is slaked to powder in a slaking drum or hardening boiler, after having been ground finely. In the mixed processes it is slaked in drums with part of the sand, and then, or perhaps after having been stored in silos, it is mixed with the rest of the sand. In the quicklime process ground-burnt lime is mixed with the entire quantity of sand, water being added steadily to the mixture, which is then pressed, either after having been stored in silos or without previous storing.

Presses of various kinds are in use which have a daily capacity of about 24,000 bricks, which are perfect in shape. Larries loaded with 900 bricks are moved into cylindrical hardening boilers, which are about 2 meters (6.56 feet) wide and 6.25 meters (20.50 feet) long, in which they remain about nine hours under a steam pressure of 8 atmospheres.

Tests for strength, etc.—In 255 tests the compressive strength varied greatly, the average, however, being 153 kilos per square centimeter (337.30 pounds per 0.155 square inch), which is the tenacity required in a brick of good quality.

Deviations from the average are less than in the clay brick, a result of the greater symmetry of the sand-lime brick in shape and structure. The loss of strength through the absorption of water averaged 14 per cent, and from the effect of frost 17 per cent. The average absorption of water amounted to 14.9 per cent weight and 26.3 per cent volume, percentages also less in the case of sand-lime bricks than with clay bricks. All bricks tested proved to be frost proof. In fire tests and in practical experience these bricks have shown the same properties as clay bricks in regard to the influence of fire and water used in extinguishing it.

Fireplaces, factory chimneys, ring ovens, etc., have been constructed with sand-lime bricks with good results. The adhesive property of the mortar on the bricks has been tested, by using the same kinds of mortar on sand-lime and clay bricks, the results being generally in favor of the former type of brick. The weight of structures made from this material is but slightly greater than though built of clay, and, according to an order issued in 1907, no greater weight may be estimated in statistical calculations than was ascertained in the use of clay bricks.

Because of their regular form and uniform dimensions, these bricks can be laid more easily, and can also more readily be cut. This regularity of form and their trim appearance has led to a frequent use of sand-lime bricks as facing stones, it being also possible to color them.

Patents for special types.—German patents 138,935 and 151,945 protect the manufacture of nonconducting bricks which are made of a mixture of sand, lime, and fuller's earth. After the steaming, bricks of this kind can be burned, and before being burned may be soaked with "wasserglas" (silicate of potassium or sodium).

German patent 158,615 protects a process for the elimination of the objection that the color of sand-lime bricks changes in rainy weather. According to this process the bricks are covered with a glaze while under steam pressure, which glaze, upon being burned with the bricks, dissolves and combines with the lime silicate in the brick. Various colored glazes may be applied. There are quite a number of other German patents relating to this industry, or branches thereof, full copies of which can probably be obtained if inquirers care to pay the fees.

USES.

The uses to which sand-lime products are put are numerous. It is claimed by the manufacturers that the bricks are suitable for use in superstructures and foundations and for all underground work, especially for sewers; that they improve with age, have great crushing strength, are low in porosity, are poor conductors of heat, and are unaffected by acids. It is also claimed that they are sanitary, and that they will not disintegrate under extreme climatic changes. On account of their uniform size, shape, and color it is said that they can be economically laid and can be made to produce a like face on both sides of an 8-inch wall. The bricks can be tinted any shade of color desired.

The sand-lime industry is not confined to the manufacture of brick. It extends to making an artificial stone (called limestone) for keystones, door and window sills, columns, capitals, etc., and sand-lime products have also been used for ornamental work, such as fountains and lawn ornaments. The latest development is the use of sand-lime brick for enameled brick.

PRODUCTION.

The following table shows the value of sand-lime products in the United States from the inception of the industry in this country to 1909:

Value of production of sand-lime brick in the United States, 1903–1909.

Year.	Number of plants.	Value of product.	Year.	Number of plants.	Value of product.
1903	16	$155,040	1907	94	$1,225,769
1904	57	463,128	1908	87	1,029,699
1905	84	972,064	1909	74	1,150,580
1906	87	1,170,005			

This table shows that the value of this product rose rapidly until 1907, the year of maximum value and also of the largest number of operating plants. As appears from the following table, the year 1909 showed an increase over 1908 in value, but did not reach the figures of 1907. It seems highly probable that the value of the product in 1910 will exceed that of 1907.

Production of sand-lime brick in the United States in 1908 and 1909, by States.

1908.

State.	Number of operating firms reporting.	Common brick.		Front brick.		Fancy brick.		Blocks, value.	Total value.
		Quantity (thousands).	Value.	Quantity (thousands).	Value.	Quantity (thousands).	Value.		
Arizona, North Dakota, and Washington	4	1,031	$8,230	140	$3,100				$11,330
Arkansas, Kansas, Minnesota, Nebraska, South Dakota, and Texas	13	26,609	174,798	1,712	20,392			$800	195,990
California	6	3,732	27,223	1,958	27,671	(a)	(a)		56,494
Colorado, Idaho, and Montana	5	1,930	20,505	2,184	28,857	(a)	(a)	3,000	52,377
Delaware, Maryland, and Virginia	6	6,805	41,171	514	6,338	(a)	(a)	(a)	116,182
Florida	5	21,014	117,040						117,040
Georgia, Kentucky, and Mississippi	5	6,093	37,557	1,035	11,423				48,980
Ohio, Illinois, and Wisconsin	6	6,074	35,814	376	3,258				39,072
Indiana	5	9,792	48,413	(a)	(a)				54,413
Iowa	3	4,701	33,784	(a)	(a)			(a)	42,881
Michigan	10	21,997	131,827	(a)	(a)				138,809
New Jersey	4	840	6,270	1,192	14,549				20,819
New York	7	7,965	52,389	(a)	(a)	(a)	(a)		57,189
North Carolina	3	(a)	(a)	(a)	(a)				14,000
Pennsylvania	5	6,899	57,812	(a)	(a)				64,123
Other States[b]		1,450	10,500	3,040	32,116	98	$2,515	72,347	(c)
Total	87	126,932	803,333	12,151	147,704	98	2,515	76,147	1,029,699
Average value per M			6.33		12.16		25.66		

[a] Included in other States.
[b] Includes all products made by less than three producers in one State to prevent disclosing individual operations.
[c] The total of other States is distributed among the States to which it belongs in order that they may be fully represented in the totals.

Production of sand-lime brick in the United States in 1908 and 1909, by States—Continued.

1909.

Arkansas, Kansas, Minnesota, Nebraska, North Dakota, South Dakota, and Texas	13	35,802	$232,564	1,811	$18,805	(b)	(b)		$251,546
California	3	(b)	(b)	(b)	(b)				30,056
Colorado, Idaho, Montana, and Washington	6	4,734	42,426	3,693	62,646	( )	(b)		105,734
Florida	6	11,466	71,748	(b)	(b)			$550	77,076
Georgia, Kentucky, and Mississippi	4	5,983	36,481						36,481
Indiana	3	6,840	32,550	(b)	(b)				32,800
Iowa	3	4,794	34,025	(b)	(b)	(b)	(b)	(b)	48,210
Delaware, Maryland, North Carolina, and Virginia	6	1,560	10,573	1,475	13,570			98,091	122,234
Michigan	11	34,217	207,082	(b)	(b)				218,226
New Jersey	3	(b)	(b)	(b)	(b)				21,925
New York	7	11,716	77,842	1,216	12,120	(b)	(b)		90,402
Ohio and Wisconsin	5	7,758	50,335	(b)	(b)				53,635
Pennsylvania	4	10,441	59,453	(b)	(b)				62,255
Other States[c]		3,482	32,256	4,629	46,499	192	$5,209	5,755	(d)
Total	74	138,793	887,335	12,824	153,640	192	5,209	104,396	1,150,580
Average value per M			6.39		11.98		27.13		

[a] Including door and window sills and building blocks.
[b] Included in other States.
[c] Includes all products made by less than three producers in one State to prevent disclosing individual operations.
[d] The total of other States is distributed among the States to which it belongs in order that they may be fully represented in the totals.

The value of the product increased in 1909, as shown by these tables, $120,881, or 11.74 per cent. In 1908 there was a decrease in value from 1907 of $196,070, or 16 per cent. In order to avoid disclosing individual operations, it has been necessary to group certain States. In 1909 reports were received from operating plants in 28 States; in 1908 from operating plants in 30 States and Territories. The States to report no production in 1909 were Arizona and Illinois.

Of the individual States, Michigan was the leader in 1909, as for several years past, and reported products valued at $218,226; this gain of $79,417, or 57.21 per cent, was the largest made and was 18.97 per cent of the total value. Florida, which was second in value of products in 1907 and 1908, was third in 1909, being displaced by New York, which reported products valued at $90,402; this was an increase for New York of $33,213, or 58.08 per cent. California, Florida, Indiana, and Pennsylvania showed decreases in value of product; and Iowa, Michigan, New Jersey, and New York showed increases. Florida had the largest decrease—$39,964, or 34.15 per cent. Michigan continued to have the largest number of operating plants, 11, which was an increase of 1 over 1908. In 1907 reports were received from 13 operating plants in Michigan. New York was next to Michigan, with 7 plants in 1909, the same number that reported in 1908.

The average price per thousand received for common sand-lime brick was $6.39 in 1909, as compared with $6.33 in 1908 and with $6.61 in 1907; for front brick, $11.98 in 1909, as against $12.16 in 1908 and $10.96 in 1907. In 1909 common brick composed 77.12 per cent of the value of all products; front brick 13.35 per cent; all other products 9.53 per cent. In 1908 these percentages were 78.02, 14.34, and 7.64, respectively.

The operating plants reporting decreased from 87 in 1908 to 74 in 1909. This is the smallest number of plants reporting since 1904.

SLATE.

By A. T. Coons.

PRODUCTION.

GENERAL CONDITIONS OF THE INDUSTRY.

The statistics of the production of slate in 1909 as presented in this report were collected for the United States Geological Survey by field agents of the United States Bureau of the Census at the same time that the more extensive statistics of labor, wages, cost of supplies, machinery used, etc., were collected for the use of that bureau.

The figures given represent the output of slate as reported by the slate quarrymen and include the quantity and the value of roofing slate and of mill stock sold by them and the value of a quantity of slate sold for other purposes. The values given for mill stock represent prices f. o. b. at the point of shipment, the mill stock being classed as rough or manufactured, according to the condition in which it is sold by the quarrymen, whether as rough blocks to slate mills or in a finished or partly finished state from mills at the quarries.

In 1908, notwithstanding the unsettled conditions of trade, labor, and finance in the United States, the output of slate as reported to the United States Geological Survey increased in value $297,597—from $6,019,220 in 1907 to $6,316,817 in 1908. In 1909, however, the industry was not able to keep up this increase and lost $875,399, the value declining from $6,316,817 in 1908 to $5,441,418 in 1909—the smallest value for output since that of 1901, when it was $4,787,525.

Roofing slate, which represents in value the larger part of the entire slate output, decreased in both quantity and value of output, while the price remained practically the same, showing a decrease of only 2 cents in the average price per square.

Mill stock, exclusive of slate sold for blackboards, school slates, etc., increased in both quantity and value, while the price remained the same per square foot, but there was a large decrease reported in quantity and value of school slates and of blackboard material.

The decrease in value for 1909 was caused largely by the trade and financial conditions of 1908, which curtailed the giving of contracts for 1909 and thereby lessened the demand for slate in that year. Local conditions, such as strikes, caving in of quarries, increased cost of labor and supplies, and high freight rates, also helped to cause the decrease.

In 1909, as in 1908, nine States contributed to the commercial output of slate in the United States. These States, named in rank of output, are Pennsylvania, Vermont, Maine, Virginia, Maryland, New York, California, New Jersey, and Georgia. In 1908 the producing States ranked in output as follows: Pennsylvania, Vermont, Maine, Virginia, New York, Maryland, California, New Jersey, and Arkansas. Maryland displaced New York in 1909 and Georgia took the place of Arkansas, which reported no output.

Maine, Maryland, and Vermont were the only States showing increase in value of output, the largest increase, $131,098, being in Vermont. Vermont and Maryland increased both in output of roofing slate and in mill stock, while Maine showed a decreased value in roofing slate and an increased value in mill stock.

The principal points of interest in connection with the slate deposits were the entrance of Georgia as a commercial factor into the slate trade and the shipment of slate from Carbon County, Pa.

ROOFING SLATE.

More than 80 per cent of the total value of the slate output is represented by slate for roofing, which is practically the only use made of the slate quarried in California, Georgia, Maryland, New Jersey, New York, and Virginia, although Pennsylvania and Vermont, producing also mill stock, show a much larger output of roofing slate than all the other States combined.

In 1909 the roofing-slate output was reported as 1,133,713 squares, valued at $4,394,597, the average price per square being $3.87; in 1908 there were reported 1,333,171 squares, valued at $5,186,167, with an average price per square of $3.89, a decrease in 1909 of 199,458 squares in quantity, of $791,570 in value, and of 2 cents in price per square.

Roofing slate is sold by "squares," a square being a sufficient number of pieces of slate of any size to cover 100 square feet of roof, with allowance generally for a 3-inch lap. The size of the pieces of slate making up a square ranges from 7 by 9 inches to 16 by 24 inches, and the number of pieces in a square ranges from 85 to 686, according to the size of the pieces. The ordinary thickness of a piece is from one-eighth to three-sixteenths of an inch, and the approximate weight per square is about 650 pounds. The slate is generally shipped in carload lots, each lot consisting of 50 to 100 squares, according to the size of the pieces.

The price per square for ordinary slate of No. 1 quality ranges from $3.50 to $10 per square f. o. b. at the quarries and depends on the color, size, thickness, smoothness, straightness, and uniformity of the pieces. Specially prepared slate, with pieces carefully selected with regard to color, quality, extra thickness and size, and extra cutting, commands from $30 to $200 per square. For ordinary slate the red slates of New York command the highest prices; the red slates of New York and the green slates of Vermont are the kinds most generally prepared for special work.

MILL STOCK.

The mill stock is nearly all furnished by the quarries of Pennsyl-
ania, Vermont, and Maine. In 1909 Maine and Vermont showed a lecided increase in the quantity and value of this material, while ennsylvania showed a decrease in production. The value of mill tock, including slate sold for all purposes other than roofing, de-
reased from $1,130,650 in 1908 to $1,046,821 in 1909, a loss of 83,829.

Both the quantity and the value of mill stock, exclusive of slate eported as sold as blackboards and school slate, increased from ,793,812 square feet, valued at $793,304, in 1908, to 5,112,894 quare feet, valued at $876,089, in 1909, an increase of 319,082 quare feet in quantity and of $82,785 in value. The price remained he same, about 17 cents per square foot, for each year.

Mill stock includes blackboards, school slates, flooring, wainscoting, ats, tiles, sinks, laundry tubs, grave vaults, sanitary ware, refrig-
rator shelves, flour bins and dough troughs for bakeries, electrical witchboards, mantels, hearths, well caps, and billiard, laboratory, itchen, and other table tops. This material is made in the form f slabs, from 1 inch to 3 inches or more thick, and is sold at prices anging from 4 cents to 50 cents per square foot, according to the ze, thickness, and quality of the slate and to the work done on it. t is sold in rough slabs by the quarrymen to the slate mills, or is illed by quarrymen operating their own mills.

It is noteworthy that quarries in Lehigh and Northampton Counties, a., report the only stock produced for school slates and blackboards. hese quarries can best produce this material on account of the nusually fine cleavage of their slate and the thickness and size of ie beds. The quantity and value of slate produced for these pur-
oses decreased greatly in 1909.

A small quantity of slate reported as applied to other uses consists iefly of slate for structural material and for flagging.

SLATE WASTE.

No extensive use has been found for the large quantity of waste hich forms an expensive but seemingly necessary product of a slate uarry. This waste amounts to about 80 per cent of the slate uarried.

Some experimenting has been done, it is said, in pulverizing the ate waste, mixing it with some binding material, forming it into ricks, and baking it like ordinary brick. The resulting brick is id to be good and durable, although more porous than ordinary ay brick. It is reported that artificial stone has also been made om slate waste. It is probable, however, that the cost of pulver-
ing the slate waste is an item that is not comparable with any milar expense involved in the making of ordinary brick or arti-
ial stone, but the fact remains that the utilization of slate waste most important for the successful working of a slate quarry, and e experiments made to that end are well worth making. In col-
cting the slate statistics for 1909 the question was asked of the arrymen whether any disposition was made of slate waste, and actically 95 per cent replied in the negative, although nearly all them remarked that any practical method of disposing of this

material economically would be of inestimable value to the quarryman. In Georgia slate waste was reported as used as a filler for fertilizer; in New York some of it was ground and used as paint, and some of the material also was used for flagging; in Vermont the waste was reported as used for paint, for building stone, for foundation work, for underpinning walls, for mending roads, and for filling low places.

The associate editor of Slate Trades' Gazette, England, has written for the magazine Slate (September, 1910) an article on this subject, from which the following extracts are made:

At the present time in Norway waste slate is being ground into a fine powder and mixed with casein * * * the nitrogenous constituent (curd) of milk. The casein may be either solid or liquid, the proportion varying according to the nature of the slate. Hard and soft slates obviously require different treatment. The casein may be pure or mixed with other substances—lime, soda, resins, or acids—according to the character of the product required. If the final resultant is required to be of any particular tint, coloring matter is introduced at this stage. The composition thus obtained is plastic, and is placed hot or cold in molds and subjected to pressure. The material is then exposed to the drying action of the air. The final product has properties identical with those of slate except that the casein, if anything, renders it harder and tougher. The casein can be made insoluble by the application of formaldehyde. The compressed slate is then ready to undergo sawing, planing, polishing, etc. * * *

All manner of fancy designs may be imprinted on the plastic slate, which may be manufactured into blocks of uniform size or in large sheets, and the thickness may, of course, be regulated by the pressure. This material could be used as a covering for walls, either internally or externally, in place of the ordinary wall paper or plaster, or to enhance the picturesqueness of the slate roof. Embossed mantelpieces could also be made and other uses would in course of time reveal themselves.

The article also states, concerning the manufacture of brick:

The chemical composition of slate bears a close resemblance to that of clay made very compact; all that is required is to bring the slate to a condition in which it can be worked and molded and formed into bricks. In order to accomplish this the slate is first crushed into a very fine powder and then screened several times. It is then run into cylinders and mixed with water to the required consistency. The process of molding and burning follow, respectively. Such bricks, it is said, will resist a pressure of over 1,100 kilograms per square centimeter.

It is also stated that the use of slate waste for paving is old and is in vogue in some French towns, particularly those in the vicinity of slate quarries. The article continues:

This system of paving was first introduced at Nantes and is peculiarly adapted for sidewalks. For want, perhaps, of "push" it has not made the headway that might have been expected. The palace of the Universal Exhibition of 1867 was partly paved with compressed slate flags. Their manufacture does not present much difficulty, as the ingredients are only slate and pitch, which is hardened by compression.

It is to be hoped that some means will ultimately be found to make the disposition of slate waste a source of income rather than of loss to the quarry.

QUANTITIES AND VALUES.

The following table shows the quantity and the value of roofing, mill, and other slate quarried in the United States in 1908 and 1909, by States and uses:

Quantity and value of roofing, mill, and other slate produced in the United States in 1908 and 1909, by States.

1908.

State.	Number of operators.	Roofing slate.			Mill stock.						Other.	Total value.
		Number of squares.	Value.	Average price per square.	Manufactured.		Rough.		Total.			
					Quantity.	Value.	Quantity.	Value.	Quantity.	Value.		
					Sq. feet.		Sq. feet.		Sq. feet.			
Arkansas	1										$2,500	$2,500
California	1	7,000	$60,000	$8.57								60,000
Maine	5	20,151	115,682	5.74	285,299	$98,025			285,299	$98,025		213,707
Maryland	6	18,521	101,204	5.46							982	102,186
New Jersey New York	2 11	18,485	130,439	4.05 8.10			1,500	$180	1,500	180		130,619
Pennsylvania	102	825,078	3,070,906	3.72	2,593,430	435,884	971,653	62,304	3,565,083	498,188	a 333,864	3,902,958
Vermont	51	402,258	1,513,580	3.76	707,563	168,441	234,367	28,470	941,930	196,911		1,710,491
Virginia	7	41,678	194,356	4.66								194,356
Total	186	1,333,171	5,186,167	3.89	3,586,292	702,350	1,207,520	90,954	4,793,812	793,304	337,346	6,316,817

1909.

State.	Number of operators.	Number of squares.	Value.	Average price per square.	Manufactured Quantity.	Manufactured Value.	Rough Quantity.	Rough Value.	Total Quantity.	Total Value.	Other.	Total value.
California	1			6.56								(b)
Georgia	1			5.75								(b)
Maine	6	18,024	$101,865	5.65	372,229	$126,017			372,229	$126,017		$227,882
Maryland	6	22,563	128,227	5.68							$1,311	129,538
New Jersey	2			4.39								(b)
New York	8	18,098	106,175	5.70	5,543	1,201	500	$60	6,043	1,261		107,436
Pennsylvania	98	626,228	2,281,779	3.64	2,419,905	364,803	969,214	76,661	3,389,119	441,464	c 169,115	2,892,358
Vermont	51	397,441	1,533,936	3.86	1,133,257	281,882	212,246	25,465	1,345,503	307,347	306	1,841,589
Virginia	7	40,880	180,775	4.42								180,775
Other States d		10,479	61,840									61,840
Total	180	1,133,713	4,394,597	3.87	3,930,934	773,903	1,181,960	102,186	5,112,894	876,089	170,732	5,441,418

a Composed of 5,036,147 school slates, valued at $42,364, and 2,388,886 square feet of blackboard material, valued at $291,500.
b Included in Other States.
c Composed of 3,650,831 school slates, valued at $32,319; 1,095,540 square feet of blackboard material, valued at $130,195; and $6,601 for slate used for structural and other purposes.
d Includes California, Georgia, and New Jersey.

The following table shows the total value of the slate produced in the United States from 1905 to 1909, inclusive:

Value of slate produced in the United States, 1905–1909, by States.

State.	1905.	1906.	1907.	1908.	1909.
Arkansas	$10,000	$5,000	$8,500	$2,500	
California	40,000	80,000	60,000	60,000	(a)
Georgia	7,500	5,000			(a)
Maine	224,254	238,681	236,606	213,707	$227,882
Maryland	151,215	130,969	116,060	102,186	129,538
New Jersey	5,360		8,000	130,619 (New Jersey and New York)	(a)
New York	66,646	72,360	83,485		107,436
Pennsylvania	3,491,905	3,522,149	3,855,640	3,902,958	2,892,358
Vermont	1,352,541	1,441,330	1,477,259	1,710,491	1,841,589
Virginia	146,786	172,857	173,670	194,356	180,775
Other States b					61,840
Total	5,496,207	5,668,346	6,019,220	6,316,817	5,441,418

a Included in Other States. b Includes California, Georgia, and New Jersey.

The following table shows the value of slate produced for roofing and for mill stock from 1905 to 1909, inclusive:

Value of roofing slate and mill stock, 1905–1909.

	Roofing slate.		Value of mill stock.	Total value.
	Number of squares.	Value.		
1905	1,241,227	$4,574,550	$921,657	$5,496,207
1906	1,214,742	4,448,786	1,219,560	5,668,346
1907	1,277,554	4,817,769	1,201,451	6,019,220
1908	1,333,171	5,186,167	1,130,650	6,316,817
1909	1,133,713	4,394,597	1,046,821	5,441,418

PRICES.

The following table shows the average price of roofing slate per square since 1902:

Average annual price per square of roofing slate for the entire country.

1902	$3.45	1906	$3.66
1903	3.88	1907	3.77
1904	3.78	1908	3.89
1905	3.69	1909	3.87

IMPORTS.

Practically no slate is imported into the United States. In 1908 slate valued at $7,227 was imported in the form of mantels, chimney pieces, roofing slate, slabs, etc.; in 1909 the importations were valued at $7,872, and included the same articles.

EXPORTS.

In comparison with the total output, the value of roofing slate exported from this country in 1909 was very small, being $209,383; in 1908, $197,216 was the value of slate exported.

SLATE INDUSTRY, BY STATES AND LOCALITIES.

The slate production of the United States is practically confined o the northeastern part of the country. Although scattered deposits, nore or less developed, occur elsewhere, the eastern slate is shipped o supply markets on the western coast as well as in the central and outhern parts of the country. The location of the principal deposits ither producing in commercial quantities or in process of development are given below by States. Nearly all of these deposits are lescribed in Bulletin No. 275 of the U. S. Geological Survey.[a]

Arizona.—A slate deposit about 6½ miles north of Phoenix, in Iaricopa County, Ariz., has never been developed.

Arkansas.—Although no slate was quarried in Arkansas in 1909, nore activity was shown in 1909 in the development of slate properies in that State than for the last three or four years, and with an ncrease of transportation facilities it is hoped that the slate will be ut on the market. Most of the Arkansas slate that has been sold as been used for electrical supplies. The Arkansas Geological urvey published in 1909 a report on the slates of Arkansas, giving ests and analyses as well as descriptions of the deposits.[b]

California.—Production in California in 1909 was limited to the utput of the Eureka Slate Company, near Slatington and Placerville, Eldorado County. Nothing was done at the deposits near Merced, Iariposa County.

Colorado.—Development work in Colorado was continued at the eposit owned by the Colorado Slate Company, at Marble, Gunnison ounty, but no slate has been marketed.

Georgia.—Slate deposits near Rockmart, Polk County, Ga., have een in the process of development for several years; and a small uantity of slate has been sold locally, but none has been reported ntil 1909. This slate was from the quarries of Ellis Davis & Son, Rockmart. Several other companies reported development work at his same place.

Maine.—The deposits of slate operated for commercial purposes n Maine are in the central part of the State, in Piscataquis County, ear the towns of Monson, Blanchard, and Brownville. No development has ever been made at the deposits in Somerset County. Maine vas one of the three States that showed an increased output of slate n 1909. The total value of slate reported from Maine in 1909 was 227,882, a gain of $14,175 as compared with $213,707 in 1908. This gain was in both quantity and value of mill stock, which increased rom 285,299 square feet, valued at $98,025, in 1908, to 372,229 quare feet, valued at $126,017, in 1909, an increase of 86,930 square eet in quantity and of $27,992 in value. The average price per square oot was 34 cents both in 1908 and in 1909. The output of roofing ate, however, decreased in both quantity and value, being reported s 20,151 squares, valued at $115,682 in 1908, and 18,024 squares, alued at $101,865, in 1909, a loss of 2,127 squares in quantity and f $13,817 in value. The price per square in 1908 was $5.74; in 909 it was $5.65.

Maryland.—The entire output of slate in Maryland in 1909 was rom the Peach Bottom region, at Cardiff, Harford County. This

[a] Dale, T. Nelson, and others, Slate deposits and slate industry of the United States: Bull. U. S. eol. Survey No. 275, 1906.

[b] Purdue, A. H., The slates of Arkansas: Geol. Survey Arkansas, 1909.

belt is a continuation of the belt in York County, Pa., and the slate quarried is used chiefly for roofing. Maryland, along with Maine and Vermont, showed an increased production in 1909 over 1908. In 1908 Maryland produced 18,521 squares of roofing slate, valued at $101,204, and 22,563 squares, valued at $128,227, in 1909, an increase of 4,042 squares in quantity and of $27,023 in value. The average price per square was $5.68 in 1909 and $5.46 in 1908.

Nevada.—No development work was done in 1909 at the slate deposit near Winnemucca in Humboldt County, Nev.

New Jersey.—The working of slate quarries in Sussex County, N. J., goes back fifty or sixty years, but has been confined to the localities at Newton and Lafayette. At one time all work in the slate quarries stopped and then, about eleven years ago, the quarries at Newton were reopened by the Newton Slate Company, and about three years ago the Lafayette Slate Company reopened the old quarries at Lafayette, in Sussex County. The following brief description from a microscopic examination of a specimen of "black" roofing slate from this quarry is furnished by T. Nelson Dale:

The slate is very dark, bluish gray. To the unaided eye it has a fine texture and a slightly roughish, lusterless cleavage surface. It contains some carbonaceous matter or graphite and very little magnetite. The sawn edge shows pyrite. It effervesces with cold dilute hydrochloric acid, is sonorous, and has a high grade of fissility.

Under the microscope this slate shows a matrix of muscovite (sericite) with fair aggregate polarization (which but for abundant carbonate would be more brilliant), and a fine even texture which, however, is considerably coarser in the ribbon. Quartz grains measure to 0.034 millimeter; and scales of chlorite, some interleaved with muscovite, up to 0.08 millimeter, are arranged across the cleavage and about in the direction of bedding. There are sparse minute spherules of pyrite and some rutile needles. The ribbons abound in carbonate, pyrite, and carbonaceous material. Their quartz grains measure to 0.05 millimeter.

The constituents, arranged in descending order of abundance, appear to be: Muscovite (sericite), carbonate, quartz, carbonaceous matter or graphite, chlorite, pyrite, rutile, magnetite.

This is a mica slate of good quality but related to those of Lehigh and Northampton counties, Pa., and thus belongs in the fading series. In general fineness of texture it resembles that of the Heimbach quarry near Slatington, Pa.

The New Jersey slate deposits are a continuation of the slate belt of Northampton and Lehigh Counties, Pa., and it is therefore quite natural that, as stated by Mr. Dale, the New Jersey slate should be like the slates of Lehigh and Northampton Counties in composition and thus belong to the fading series of slates. It is particularly noticeable, however, that roofs constructed of this slate thirty or forty years ago show little if any difference in color from roofs recently covered with this slate and that on account of its dark color the slate on roofs covered with this slate can readily be distinguished from slate obtained from other localities. It is hoped that a closer study of changes of color in this slate due to length of exposure to the weather can be made, as the operators of the quarries claim that the slate is absolutely unfading. As but two firms operate in New Jersey, the production of the State can not be given, but it was somewhat less in 1909 than in 1908. The average price per square was $4.05 in 1908 and $4.39 in 1909. This slate therefore commands a higher price than the average Pennsylvania slate.

New York.—The slate deposits of New York are in Washington County, in the same belt as the deposits of Vermont. The New York output, however, is chiefly red slate, which commands very high prices per square for roofing and is now the only red slate on he market. Almost all the slate quarried was sold for roofing, and howed a decrease in value but an increase in quantity in 1909 over 908. The average price per square was $8.10 in 1908 and $5.87 ı 1909, the great difference being due to the sale of more low-priced late.

Pennsylvania.—The output of slate from Pennsylvania was valued t $2,892,358 in 1909 and at $3,902,958 in 1908, a decrease in 1909 of 1,010,600. Notwithstanding this large decrease, the value of the utput in 1909 was 53.15 per cent of the total value of the slate prouced in the United States; this per cent for 1908 was 61.79.

The roofing slate of this State represented 51.92 per cent of the alue of the roofing slate produced in the United States in 1909 and 9.21 per cent in 1908. The mill stock represented 58.32 per cent of 1e value of all other slate produced in the country in 1909 and 73.59 er cent in 1908. The roofing slate production decreased from 25,078 squares, valued at $3,070,906, in 1908, to 626,228 squares, alued at $2,281,779, in 1909, a loss in 1909 of 198,850 squares and f $789,127 in value. The average price per square was $3.64 in 909 and $3.72 in 1908.

Prior to 1909 all the slate produced in Pennsylvania was quarried ı Lehigh, Northampton, and York Counties. In 1909, however, a roduction of roofing slate was reported from Aquashicola, Carbon ounty, by Lewis & Bray. The following brief description from a icroscopic examination of "black" roofing slate from this quarry furnished by T. Nelson Dale:

The slate is of very dark bluish-gray color. To the unaided eye it has a very fine ıt banded texture and roughish, lusterless cleavage surface. It contains considerole carbonaceous or graphitic matter and a little magnetite. The sawn edge shows ery minute pyrite particles. The rough edge effervesces with cold dilute hydroıloric acid. It is sonorous, and has a high grade of fissility. The ribbons do not opear to be lines of weakness.

Under the microscope this slate shows a matrix of muscovite (sericite) with fairly od aggregate polarization, and is thus a mica slate. The cleavage is fine and crosses e bedding in the specimen at 17°. Quartz particles measure to 0.02 millimeter and oundant spherules of pyrite to 0.017 millimeter in diameter. There is considerable rbonate, but not an excessive amount of it. Chlorite and the usual slate needles are esent.

The constituents of the slate, in descending order of abundance, appear to be: uscovite, quartz, carbonate, chlorite, carbon, kaolin, pyrite, magnetite, and rutile. Although this belongs to the fading series of mica slates and its surface is somewhat ugh, it ought to prove serviceable.

In 1909 Pennsylvania produced 55.24 per cent of the total quantity roofing slate produced in the United States. Northampton County roduced 68.36 per cent of the Pennsylvania output and 37.76 per ent of the total quantity for the United States; Lehigh County proıced 29.58 per cent of the Pennsylvania output and 16.34 per cent the total quantity for the United States. Northampton and ehigh County slate is also used for mill stock and is the only school nd blackboard slate reported in the United States. York County roduces the Peach Bottom slate and is on the same slate belt as the ate of Harford County, Md.

Besides roofing slate Pennsylvania has a larger output of mill ock than any other State, producing, exclusive of blackboard stock nd school slate, 50.39 per cent of the total value and 66.29 per cent the total quantity of this material for the United States. The mill ock quarried in Pennsylvania, exclusive of school slates and blackoards, amounted to 3,565,083 square feet, valued at $498,188, in

1908, and to 3,389,119 square feet, valued at $441,464, in 1909, a decrease for 1909 of 175,964 square feet in quantity and of $56,725 in value. The average price per square foot of mill stock, both rough and manufactured, exclusive of blackboard and school slate, in Pennsylvania was 13 cents in 1909 and 14 cents in 1908.

The material sold for blackboards decreased from 2,388,886 square feet, valued at $291,500, in 1908, to 1,095,540 square feet, valued at $130,195, in 1909, a decrease of 1,293,346 square feet in quantity and of $161,305 in value. The average price of blackboard material was 11.8 cents per square foot in 1909 and 12 cents in 1908.

The school slate production reported decreased from 5,036,147 slates, valued at $42,364, in 1908, to 3,650,831 slates, valued at $32,319, in 1909, a decrease of 1,385,316 slates in quantity and of $10,045 in value. The average price of school slates was $8.85 per thousand in 1909 and $8.41 per thousand in 1908. The average size of slates sold is 7 by 11 inches.

The following table shows in detail the production of slate in Pennsylvania, by counties and uses, in 1908 and 1909:

Production of slate in Pennsylvania in 1908 and 1909, by counties and uses.

1908.

County.	Number of operators.	Roofing slate.			Mill stock.								Other (value).	Total value.
					Manufactured.		Rough.		Blackboards.		School slates.			
		Number of squares.	Value.	Price per square.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.		
					Square feet.		*Square feet.*		*Square feet.*		*Number.*			
York	4	15,450	$82,500	$5.34										$82,500
Lehigh	32	198,653	750,653	3.78	109,196	$25,886	375,153	$33,796	1,499,992	$167,282	2,627,220	$21,457		999,074
Northampton	66	610,975	2,237,753	3.66	2,484,234	409,998	596,500	28,508	888,894	124,218	2,408,927	20,907		2,821,384
Total	102	825,078	3,070,906	3.72	2,593,430	435,884	971,653	62,304	2,388,886	291,500	5,036,147	42,364		3,902,958

1909.

County.	Number of operators.	Number of squares.	Value.	Price per square.	Manufactured quantity.	Manufactured value.	Rough quantity.	Rough value.	Blackboards quantity.	Blackboards value.	School slates quantity.	School slates value.	Other (value).	Total value.
Carbon	1	} 12,843	77,129	{ 3.69	}									77,129
York	3			{ 6.19										
Lehigh	37	185,249	670,443	3.62	147,313	40,119	575,903	47,208	289,132	21,747	1,885,221	15,170	$5,398	800,085
Northampton	57	428,136	1,534,207	3.58	2,272,592	324,684	393,311	29,453	806,408	108,448	1,765,610	17,149	1,203	2,015,144
Total	98	626,228	2,281,779	3.64	2,419,905	364,803	969,214	76,661	1,095,540	130,195	3,650,831	32,319	6,601	2,892,358

The quantity and value of blackboard and school slate given in this table do not necessarily represent the entire quantity and value of these articles made, but the quantity and value of the material sold as such by the quarrymen. It is possible that some of the rough mill stock sold to the slate mills by the quarrymen was used for blackboards and school slates. This office collects the slate statistics from the quarrymen and not from the manufacturers, for if figures from dealers and slate-mill operators were included it would be almost impossible to avoid duplication. On the other hand it is impossible to obtain the value of the rough slate stock from the quarryman who mills his own slate, as the value of the material to him is its value at the completion of his work. In like manner the quarryman does not always know the purpose for which the material will be used when it is sold by him to a slate mill.

Tennessee.—No slate was reported as marketed in Tennessee in 1909, although some development work was done. The deposits are located in Blount, Monroe, and Washington Counties.

Utah.—No slate was shipped from Utah in 1909. The deposit under development is near Provo City, Utah County.

Vermont.—Vermont ranks next to Pennsylvania in the production of slate, and in 1909 produced 33.84 per cent of the total value of the United States output as compared with 53.15 per cent produced by Pennsylvania; in 1908 these figures for Vermont and Pennsylvania were 27.08 per cent and 61.79 per cent, respectively—an increase for Vermont and a loss for Pennsylvania in 1909. Vermont was one of the three States showing an increased output in 1909 as compared with 1908, and this increased value of product was for both roofing slate and mill stock. The quantity, however, of roofing slate decreased. The total value of the output in Vermont was $1,841,589 in 1909, an increase of $131,098 as compared with $1,710,491 in 1908.

The roofing slate produced amounted to 397,441 squares, valued at $1,533,936, in 1909, and to 402,258 squares, valued at $1,513,580, in 1908, a decrease in 1909 of 4,817 squares in quantity and an increase of $20,356 in value. The average price per square was $3.86 in 1909 and $3.76 in 1908. The output of mill stock increased from 941,930 square feet, valued at $196,911, in 1908, to 1,345,503 square feet, valued at $307,347, in 1909, an increase of 403,573 square feet in quantity and of $110,436 in value. Of the total value of mill stock produced in the United States, Vermont produced 35.08 per cent, compared with 50.39 per cent from Pennsylvania (exclusive of blackboards and school slates).

The Vermont slate is practically all from Rutland County and the quarries are in the same slate belt as the New York slate quarries. There are some deposits in Washington County, but they are not worked.

The trade in Vermont is gradually recovering from the effects of the strike of 1907–8, a strike which caused the fluctuations in the slate production of the State during the last two years.

Virginia.—There was a slight decrease in the quantity and in the value of the slate output in Virginia in 1909 as compared with 1908. The output in 1909 was 40,880 squares, valued at $180,775; in 1908 it was 41,678 squares, valued at $194,356, a loss in 1909 of 798 squares in quantity and of $13,581 in value. The average price per square was $4.66 in 1908 as compared with $4.42 in 1909.

STONE.

By Ernest F. Burchard.

INTRODUCTION.

The value of the stone produced in the United States in 1909 was $71,345,199, as compared with $65,712,499 in 1908 and with $71,105,805 in 1907. The large increase over the production of 1908, a year of general depression, was to be expected; the increase over the production of 1907 is noteworthy, since 1907 was until near the close of the quarrying season a very prosperous year. The year 1909 surpassed all previous years in the value of its stone output. The values of granite, trap rock, and limestone each showed an increase in 1909 over those of 1907 and 1908; the value of sandstone produced in 1909 was greater than that for 1908; but the values of bluestone and marble both decreased slightly in 1909 as compared with those in 1907 and 1908.

In 1909 the total value of the stone output for Pennsylvania exceeded that for any other State. Pennsylvania has held first rank in previous years except 1908, when Vermont reported the largest production.

The statistics of stone production for 1909 have been collected by the United States Geological Survey in cooperation with the Bureau of the Census, and the securing of the replies to the numerous and detailed inquiries contained in the general census schedule has delayed the publication of the statistics far beyond the time at which the Geological Survey usually presents them to the public.

The figures presented in the following report, as in previous years, have to do with the stone produced and sold by the quarrymen and include only such manufactured product as is put on the market by the quarrymen themselves. This applies especially to dressed building stone, dressed monumental stone, crushed stone, flagstone, curbstone, and paving blocks. The value given to this manufactured product is the price received by the producer, free on board at point of shipment, and includes therefore the cost of labor necessary to dress the stone. The stone reported as sold rough includes stone sold as rough stock to monumental works, and to cut-stone contractors for building purposes; stone sold as riprap, rubble, and flux; and includes the value of only such labor as is required to get the stone out of the quarry in the shape required by the purchaser. The value given to this stone is the price received by the quarryman free on board at point of shipment. In case the stone is sold to local trade the value is given as the quarryman sells the material, generally at the quarry, but in some cases delivered, if this is done by the producer. In some instances a long haul to market or to the railroad increases the cost of the material, and therefore of the selling price.

UNIT OF MEASUREMENT.

Owing to the variety of uses to which stone is put there is no regular unit of measurement employed by the quarrymen, the stone being sold by the cubic yard, the cubic foot, the ton, cord, perch, rod, square foot, square yard, square, etc. Building and monumental stone, especially the dressed product, is usually sold by the cubic foot or the cubic yard, although this unit varies with the class of stone and with the locality; a large quantity of the rough stone is sold by the perch, cord, and ton. Rubble and riprap, including stone for heavy masonry, such as breakwater and jetty work, are generally sold by the cord and ton. Fluxing stone and stone for chemical use—as for alkali works, sugar factories, carbonic-acid plants, paper mills, etc.—are sold by the long ton. Flagstone and curbstone are sold by the square yard and the square foot, the thickness being variable and depending on the order received by the quarrymen. Paving blocks are sold invariably by number of blocks, and as such have been tabulated and published for several years; these blocks, however, are not of uniform size, the value depending on the size and amount of labor necessary to cut the block into the shape desired. Crushed stone is reported as sold by the cubic yard or ton, the short ton being more generally used. The weight of a cubic yard varies from 2,300 to 3,000 pounds, the average weight being 2,500 pounds. In certain localities this crushed stone is sold by the "square" of 100 square feet by 1 foot, or 100 cubic feet to a square. It is also of interest to note the selling of crushed stone by the bushel, 21½ bushels representing a cubic yard of about 2,700 pounds. As most of the crushed-stone producers report the quantity according to some unit, it has been possible to convert the crushed stone into short tons, which unit represents the larger number of producers and is the most convenient.

The cards showing the production of building stone, monumental stone, rubble, and riprap, do not always report the quantity, and Vermont is the only State for which the quantity as well as the value has been published.

PRODUCTION.

For simplicity of treatment the kinds of stone covered by the figures in this report are classified as granite, trap rock, sandstone, bluestone, limestone, and marble.

Granite includes true granites and other igneous rocks, as gneiss, mica schist, andesite, syenite, trachyte, quartz porphyry, lava, tufa, diabase, basalt, diorite, gabbro, dolerite, and a small quantity of serpentine. Rocks of these kinds are as a rule quarried commercially in quantities too small to permit their being tabulated separately, but the trap-rock output for California, Massachusetts, New York, New Jersey, and Pennsylvania represents an important industry, and it is therefore considered advisable to show the value of this stone separately. The trap rock from these States consists largely of basalt.

Sandstone includes the quartzites of South Dakota and Minnesota and the fine-grained sandstones of New York and Pennsylvania, known to trade as bluestone. As the bluestone is a product of a distinct industry, its production is also shown apart from that of the other sandstones. Bluestone is also quarried in New Jersey and West Virginia, but this product is small and is not separated from sandstone. In Kentucky most of the sandstone quarried and sold is known locally as freestone. The figures given for sandstone do not include the value of the grindstones, whetstones, and pulpstones made from sandstones quarried in Michigan, Ohio, and West Virginia; nor does the total sandstone value include sandstone crushed into sand and used in the manufacture of glass and as molding sand. The production of these materials is published in other chapters of this volume.

Limestone does not include limestone burned into lime, bituminous limestone, nor limestone entering into the manufacture of Portland cement. It includes, however, a small quantity of stone sold locally as marble, and also in the crushed stone a quantity of material known as "chats," or the tailings from the zinc mines of Missouri, and some chert from Alabama.

Marble includes a small quantity of serpentine quarried and sold as marble in Georgia and Pennsylvania, and also a small quantity of the so-called "onyx" marble or travertine obtained from caves and other deposits.

The following table shows the value of the different kinds of stone produced in the United States from 1899 to 1909, inclusive:

Value of the different kinds of stone produced in the United States, 1899–1909.

Year.	Granite.	Trap rock.	Sandstone.	Bluestone.	Marble.	Limestone.	Total.
1899	$10,343,298	$1,275,041	$4,910,111	$815,284	$4,011,681	$13,889,302	$35,244,717
1900	10,969,417	1,706,200	5,272,865	1,198,519	4,267,253	13,556,523	36,970,777
1901	14,266,104	1,710,857	6,974,199	1,164,481	4,965,699	18,202,843	47,284,183
1902	16,083,475	2,181,157	9,430,958	1,163,525	5,044,182	20,895,385	54,798,682
1903	15,703,793	2,732,294	9,482,802	1,779,457	5,362,686	22,372,109	57,433,141
1904	17,191,479	2,823,546	8,482,162	1,791,729	6,297,835	22,178,964	58,765,715
1905	17,563,139	3,074,554	8,075,149	1,931,625	7,129,071	26,025,210	63,798,748
1906	18,562,806	3,736,571	7,147,439	2,021,898	7,582,938	27,327,142	66,378,794
1907	18,064,708	4,594,103	6,753,762	2,117,916	7,837,685	31,737,631	71,105,805
1908	18,420,080	4,282,406	5,831,231	1,762,860	7,733,920	27,682,002	65,712,499
1909	19,581,597	5,133,842	6,564,052	1,446,402	6,548,905	32,070,401	71,345,199

From this table it will be seen that the stone output of the United States increased $5,632,700 in value, from $65,712,499 in 1908 to $71,345,499 in 1909.

Granite.—The value of granite represented 27.4 per cent of the total stone value in 1909. The increase in value was from $18,420,080 in 1908 to $19,581,597 in 1909, or $1,161,517. While granite for paving blocks and curbing increased somewhat in value, the decided increase was in the value of building granite. The value of granite for monumental work and for flagging decreased.

Trap rock.—Trap rock increased in value from $4,282,406 in 1908 to $5,133,842 in 1909, or $851,436. This stone represented nearly 7.2 per cent of the total stone output in 1909. The trap-rock output is chiefly crushed stone.

Sandstone.—Sandstone, including bluestone, represented 11.23 per cent of the total output, and increased in value from $7,594,091 in 1908 to $8,010,454 in 1909, a gain of $416,363.

Marble.—Marble represented nearly 9.2 per cent of the total output and decreased in value $1,185,015, from $7,733,920 in 1908 to $6,548,905 in 1909.

Limestone.—Limestone represented 44.9 per cent of the total production and gained $4,388,399, the value being $32,070,401 in 1909 as against $27,682,002 in 1908.

The following table shows the value of the various kinds of stone produced in 1908 and 1909, by States and Territories:

Value of various kinds of stone produced in 1908 and 1909, by States and Territories.

1908.

State or Territory.	Granite.	Trap rock.	Sandstone.	Marble.	Limestone.	Total value.
Alabama			$34,099	[a] $118,580	$479,730	[a] $632,409
Alaska				[a] 103,888		[a] 103,888
Arizona	$8,544		396,358		[b] 50,130	[b] 455,032
Arkansas	152,567		42,463		61,971	257,001
California	1,684,504	$979,139	330,214	60,408	237,320	3,291,585
Colorado	121,282		181,051	([a])	378,822	[a] 681,155
Connecticut	592,904	473,219	55,949		[b] 3,727	[b] 1,125,799
Delaware	195,761					195,761
Florida					41,910	41,910
Georgia	970,832			916,281	8,495	1,895,608
Hawaii	81,219					81,219
Idaho			33,394		36,000	69,394
Illinois			12,218		3,122,552	3,134,770
Indiana			3,342		3,643,261	3,646,603
Iowa			2,337		530,945	533,282
Kansas			67,950		403,176	471,126
Kentucky			78,732	([a])	810,090	[a] 888,822
Maine	2,027,508				([b])	[b] 2,027,508
Maryland	762,442		6,262	[a] 79,317	128,591	[a] 976,612
Massachusetts	2,027,463	508,672	241,462	175,648	1,950	2,955,195
Michigan			39,103		669,017	708,120
Minnesota	629,427		197,184		667,095	1,493,706
Missouri	157,968		17,954	([a])	2,130,136	[a] 2,306,058
Montana			51,564		134,595	186,159
Nebraska			[c] 15,815		330,570	[c] 346,385
Nevada			([c])			([c])
New Hampshire	867,028					867,028
New Jersey	125,804	1,079,514	154,422		172,000	1,531,740
New Mexico			[c] 10,410	([a])	([b])	[a b c] 10,410
New York	367,066	723,953	[d] 1,774,843	706,858	2,584,559	[d] 6,157,279
North Carolina	764,272		[c] 12,266	([a])	([b])	[a b c] 776,538
North Dakota			([c])			([c])
Ohio			1,244,752		3,519,557	4,764,309
Oklahoma	23,239		57,124		257,066	337,429
Oregon	271,869		([c])		6,230	[c] 278,099
Pennsylvania	324,241	517,909	[d] 1,368,784	102,747	4,057,471	[d] 6,371,152
Rhode Island	556,474				([b])	[b] 556,474
South Carolina	297,874					297,874
South Dakota			128,554		([b])	[b] 128,554
Tennessee			([c])	790,233	[b] 535,882	[b c] 1,326,115
Texas	190,055		154,948		314,571	659,574
Utah	5,229		25,097	([a])	253,088	[a] 283,414
Vermont	2,451,933			4,679,960	20,731	7,152,624
Virginia	321,530		([c])		280,542	[c] 602,072
Washington	870,944		464,587		31,660	1,367,191
West Virginia			127,149		645,385	772,534
Wisconsin	1,529,781		219,130		1,102,009	2,850,920
Wyoming			44,574		[b] 31,168	[b] 75,742
Other States	40,320					40,320
Total	[e] 18,420,080	4,282,406	[f] 7,594,091	7,733,920	27,682,002	65,712,499

[a] To prevent disclosure of individual production: Alabama includes Kentucky and Missouri; Alaska includes Colorado, New Mexico, and Utah; Maryland includes North Carolina.

[b] Arizona includes New Mexico; Connecticut includes Maine and Rhode Island; Tennessee includes North Carolina; Wyoming includes South Dakota.

[c] Nebraska includes North Dakota and Oregon; Nevada is included with New Mexico; North Carolina includes Tennessee and Virginia.

[d] Includes bluestone.

[e] Includes a small value for trap, basalt, and other igneous rocks.

[f] Includes quartzite and bluestone.

Value of various kinds of stone produced in 1908 and 1909, by States and Territories—Continued.

1909.

State or Territory.	Granite.	Trap rock	Sandstone.	Marble.	Limestone.	Total value.
Alabama			$77,327	[a] $212,462	$700,642	$990,431
Alaska				[a] 46,900		46,900
Arizona	([b])		298,335	([a])	([c])	298,335
Arkansas	$150,179		67,956		112,468	330,603
California	1,310,520	$1,471,085	290,034	89,392	283,869	3,444,900
Colorado	74,326		197,105	[a] 488,311	355,136	1,114,878
Connecticut	610,514	367,655	([d])		[c] 5,023	983,192
Delaware	456,328					456,328
Florida					[c] 49,856	49,856
Georgia	843,542			766,449	34,593	1,644,584
Hawaii	68,955				([c])	68,955
Idaho	([b])		29,263		([c])	29,263
Illinois			26,891		4,234,927	4,261,818
Indiana			4,119		3,749,239	3,753,358
Iowa			2,443		525,277	527,720
Kansas			19,560		892,335	911,895
Kentucky			90,835	([a])	903,874	994,709
Louisiana					([c])	([c])
Maine	1,939,524				([c])	1,939,524
Maryland	771,224		10,584	([a])	197,939	979,747
Massachusetts	2,164,619	673,502	[d] 457,962	243,711		3,539,794
Michigan	([b])		36,084		750,589	786,673
Minnesota	[b] 660,823		299,358		698,309	1,658,490
Missouri	155,717		28,763		2,111,283	2,295,763
Montana	([b])		73,443		154,064	227,507
Nebraska					293,830	293,830
Nevada			([d])			([d])
New Hampshire	1,215,461					1,215,461
New Jersey	60,175	1,140,571	189,098		224,017	1,613,861
New Mexico	([b])		4,963	[a] 5,390	[c] 140,801	151,154
New York	443,910	760,776	[f] 1,430,830	402,729	2,622,353	5,660,598
North Carolina	743,876			([a])	([c])	743,876
North Dakota			([d])			([d])
Ohio			1,639,006		4,020,046	5,659,052
Oklahoma	67,584		59,855		450,055	577,494
Oregon	284,135		[d] 4,811	([a])		288,946
Pennsylvania	507,814	720,253	[f] 1,637,794	186,037	5,073,825	8,125,723
Rhode Island	933,053				([c])	933,053
South Carolina	218,045					218,045
South Dakota			[d] 118,029		[c] 49,328	167,357
Tennessee			([d])	613,741	[c] 589,949	1,203,690
Texas	173,271		61,600	([a])	341,528	576,399
Utah	7,525		71,235	([a])	169,700	248,460
Vermont	2,811,744			3,493,783	18,839	6,324,366
Virginia	488,250		28,574		342,656	859,480
Washington	742,878		335,470	([a])	38,269	1,116,617
West Virginia			[d] 201,038	([a])	864,392	1,065,430
Wisconsin	1,442,305		204,959		1,047,044	2,694,308
Wyoming			13,130		24,346	37,476
Other States	[b] 235,300					235,300
Total	[e] 19,581,597	5,133,842	[f g] 8,010,454	6,548,905	32,070,401	71,345,199

[a] To prevent disclosure of individual production; Alabama includes Kentucky, Maryland, North Carolina, and West Virginia; Alaska includes Washington; New Mexico includes Arizona and Texas; Colorado includes Oregon and Utah.

[b] Minnesota includes a small value of trap rock for Michigan and Minnesota; "Other States" includes Arizona, Idaho, Montana, and New Mexico.

[c] Connecticut includes Maine and Rhode Island; Florida includes Louisiana; New Mexico includes Arizona; South Dakota includes Hawaii and Idaho; Tennessee includes North Carolina.

[d] Massachusetts includes Connecticut; Oregon includes Nevada; South Dakota includes North Dakota; West Virginia includes Tennessee.

[e] Includes small values for trap, basalt, and other igneous rocks.

[f] Includes bluestone.

[g] Includes quartzite in California, Minnesota, South Dakota, and Wisconsin.

The following table shows the rank of States and Territories in 1908 and 1909, according to value of production of stone, and the percentage of the total produced by each State or Territory:

Rank of States and Territories in 1908 and 1909, according to value of production of stone, and percentage of total produced by each State or Territory.

1908.				1909.			
Rank of State.	State or Territory.	Total value.	Percentage of total.	Rank of State.	State or Territory.	Total value.	Percentage of total.
1	Vermont	$7,152,624	10.88	1	Pennsylvania	$8,125,723	11.39
2	Pennsylvania	6,371,152	9.70	2	Vermont	6,324,366	8.86
3	New York	6,157,279	9.37	3	New York	5,660,598	7.93
4	Ohio	4,764,309	7.25	4	Ohio	5,659,052	7.93
5	Indiana	3,646,603	5.55	5	Illinois	4,261,818	5.97
6	California	3,291,585	5.01	6	Indiana	3,753,358	5.26
7	Illinois	3,134,770	4.77	7	Massachusetts	b 3,539,794	4.96
8	Massachusetts	2,955,195	4.50	8	California	3,444,900	4.83
9	Wisconsin	2,850,920	4.34	9	Wisconsin	2,694,308	3.78
10	Missouri	a 2,306,058	3.51	10	Missouri	2,295,763	3.22
11	Maine	a 2,027,508	3.09	11	Maine	b 1,939,524	2.72
12	Georgia	1,895,608	2.88	12	Minnesota	b 1,658,490	2.32
13	New Jersey	1,531,740	2.33	13	Georgia	1,644,584	2.31
14	Minnesota	1,493,706	2.27	14	New Jersey	1,613,861	2.26
15	Washington	1,367,191	2.08	15	New Hampshire	1,215,461	1.70
16	Tennessee	a 1,310,651	1.99	16	Tennessee	1,163,915	1.63
17	Connecticut	a 1,125,799	1.71	17	Washington	1,116,617	1.57
18	Maryland	968,437	1.47	18	Colorado	b 1,114,878	1.56
19	Kentucky	893,447	1.36	19	West Virginia	b 1,065,205	1.49
20	New Hampshire	867,028	1.32	20	Maryland	b 1,023,255	1.43
21	North Carolina	800,177	1.22	21	Kentucky	b 994,709	1.39
22	West Virginia	772,534	1.18	22	Connecticut	b 983,192	1.38
23	Colorado	a 740,253	1.13	23	Rhode Island	b 933,053	1.31
24	Michigan	a 708,120	1.08	24	Alabama	b 924,140	1.30
25	Texas	659,574	1.00	25	Kansas	911,895	1.28
26	Alabama	627,011	.95	26	Virginia	859,480	1.21
27	Virginia	a 602,072	.92	27	North Carolina	806,659	1.13
28	Rhode Island	a 556,474	.85	28	Michigan	b 786,673	1.10
29	Iowa	533,282	.81	29	Texas	b 579,589	.81
30	Kansas	471,126	.72	30	Oklahoma	577,494	.81
31	Arizona	451,832	.69	31	Iowa	527,720	.74
32	Nebraska	338,070	.51	32	Delaware	456,328	.64
33	Oklahoma	337,429	.51	33	Arkansas	330,603	.46
34	South Carolina	297,874	.45	34	Arizona	b 316,938	.44
35	Utah	286,414	.44	35	New Mexico	300,313	.42
36	Oregon	a 286,414	.44	36	Nebraska	293,830	.41
37	Arkansas	257,001	.39	37	Oregon	b 284,135	.40
38	Montana	a 225,709	.34	38	Montana	b 276,560	.39
39	Delaware	195,761	.30	39	Utah	b 248,460	.35
40	South Dakota	131,994	.20	40	South Carolina	218,045	.31
41	Hawaii	81,219	.12	41	South Dakota	b 148,411	.21
42	Wyoming	72,947	.11	42	Hawaii	b 68,955	.10
43	Idaho	a 69,394	.11	43	Idaho	68,315	.10
44	Florida	41,910		44	Alaska	b 46,900	.07
45	Alaska	a 40,343	.15	45	Wyoming	37,476	.05
46	New Mexico	15,955		46	Louisiana	49,856	.07
47	Nevada	(a)		47	Florida		
48	North Dakota	(a)		48	North Dakota	(b)	
				49	Nevada	(b)	
	Total	65,712,499	100.00		Total	71,345,199	100.00

a To prevent disclosure of individual production, Alaska includes a small value for Nevada; Colorado for Missouri; Connecticut for Maine and Rhode Island; Montana for Idaho and Michigan; Oregon for North Dakota; and Tennessee for Virginia.

b To prevent disclosure of individual production, Alaska includes a small value for Washington; Alabama for West Virginia; Colorado for Oregon and Utah; Connecticut for Maine and Rhode Island; Massachusetts for Connecticut; Maryland for Kentucky; Montana for North Dakota; Minnesota for Michigan; South Dakota for Hawaii, Idaho, Nevada, and Oregon; and Texas for Arizona.

The following table shows the value of the stone used for various purposes in 1908 and 1909. Only such values are given as are for uses common to two or more varieties of stone.

Value of granite, trap rock, sandstone, limestone, and marble used for various purposes in 1908 and 1909.

1908.

Kind.	Building (rough and dressed).	Monumental (rough and dressed).	Flagstone.	Curbstone.	Paving stone.	Crushed stone.
Granite	$5,751,258	$4,551,061	$70,744	$942,722	$2,420,554	$2,445,268
Trap rock	40,543				184,125	4,002,220
Sandstone	2,605,381		1,067,334	1,025,259	654,896	906,317
Limestone	4,566,522		79,081	237,579	276,637	12,908,207
Marble	3,076,926	2,397,780				
Total	16,040,630	6,948,841	1,217,159	2,205,560	3,536,212	20,262,012

1909.

Kind.	Building (rough and dressed).	Monumental (rough and dressed).	Flagstone.	Curbstone.	Paving stone.	Crushed stone.
Granite	$6,532,872	$4,347,992	$47,230	$1,030,568	$2,743,117	$3,064,010
Trap rock	33,529				226,663	4,749,086
Sandstone	3,349,519		955,283	937,767	600,200	1,212,931
Limestone	4,797,268		41,343	214,140	188,680	15,052,753
Marble	2,881,267	1,756,198				
Total	17,594,455	6,104,190	1,043,856	2,182,475	3,758,660	24,078,780

This table shows from a point of view slightly different from that of the preceding tables the changes in the stone industry from 1908 to 1909. The value of stone sold for building purposes showed the substantial increase of $1,553,825, which was mainly confined to the output of granite and sandstone. The use of marble for building purposes decreased slightly in 1909. Monumental stone decreased also in value in 1909, granite and marble showing a falling off of $844,651. Flagstone showed a decrease in value of $173,303, granite, sandstone, and marble flagstones each showing a loss as compared with 1908. The total value of curbstone showed a slight loss of $23,085 in 1909, as compared with the value for 1908. The value of granite used for curbing increased, but the value of both sandstone and limestone decreased. The value of stone used for paving increased $222,448. Both granite and trap-rock values showed an increase, but the value of sandstone and limestone, the materials least used for paving blocks, decreased slightly. Crushed stone increased $3,816,768 in value in 1909 above the value in 1908. This large increase was shared by the granite, trap rock, sandstone, and limestone which constituted the output of crushed stone. The increase in concrete construction work and in railway ballasting was largely responsible for the increased demand for crushed stone.

The following table gives in a form convenient for comparison the value of building stone and of crushed stone from 1900 to 1909. The increase in the value of the crushed stone output has been more steady than that of the building stone.

Value of building stone and of crushed stone, 1900–1909.

Year.	Building stone(rough and dressed).	Crushed stone.	Year.	Building stone (rough and dressed).	Crushed stone.
1900	$10,672,598	$6,525,368	1905	$20,240,809	$16,419,614
1901	15,112,600	8,560,432	1906	20,681,625	17,467,486
1902	20,790,341	11,480,959	1907	16,675,811	22,054,297
1903	19,795,491	13,188,938	1908	16,040,630	20,262,012
1904	18,883,455	15,530,122	1909	17,594,455	24,078,780

The following table shows the quantity and value of crushed stone produced in the United States in 1908 and 1909, by States and Territories and by uses:

Production of crushed stone in 1908 and 1909, by States and Territories and by uses, in short tons.

1908.

State or Territory.	Road making.		Railroad ballast.		Concrete.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Alabama	99,330	$43,028	3,250	$1,500	21,446	$16,651	124,026	$61,179
Arizona	200	100	5,000	2,500	4,726	4,220	9,926	6,820
Arkansas	11,779	9,123			124,450	109,171	136,229	118,294
California	983,644	719,362	260,440	200,751	622,290	502,947	1,866,374	1,423,060
Colorado			4,000	2,000	8,541	6,210	12,541	8,210
Connecticut	370,735	201,540	200,000	100,000	317,702	156,840	888,437	458,380
Delaware	80,235	69,462	52,377	37,065	29,904	25,922	162,516	132,449
Florida	10,733	9,660					10,733	9,660
Georgia	4,396	3,291	28,832	11,443	68,647	52,666	101,875	67,400
Hawaii	28,269	22,035			42,814	49,219	71,083	71,254
Illinois	1,284,812	729,217	771,430	384,827	1,716,912	851,889	3,773,154	1,965,933
Indiana	1,177,435	622,726	262,819	95,165	159,211	77,011	1,599,465	794,902
Iowa	107,211	75,806	42,545	28,687	266,628	181,708	416,384	286,201
Kansas	68,100	48,550	168,789	99,306	107,006	78,540	343,895	226,396
Kentucky	469,818	350,577	525,055	235,802	57,035	35,928	1,051,908	622,307
Maine	3,517	2,557	300	150	11,285	9,818	15,002	12,525
Maryland	280,189	268,821	115,772	68,267	137,719	161,107	533,680	498,195
Massachusetts	587,338	456,413	76,800	39,963	310,494	248,330	974,632	744,706
Michigan	324,842	188,910	82,000	33,900	162,234	75,600	569,076	298,410
Minnesota	87,014	66,609	56,355	44,793	156,306	125,536	299,675	236,938
Missouri	1,275,926	732,823	232,777	130,296	459,668	357,509	1,968,371	1,220,628
Montana			1,511	756			1,511	756
Nebraska	56,037	51,007	17,651	16,010	195,669	173,449	269,357	240,466
Nevada	1,415	218					1,415	218
New Hampshire	5,219	6,329			13,235	10,126	18,454	16,455
New Jersey	774,764	609,324	482,644	254,550	360,536	266,874	1,617,944	1,130,748
New Mexico	570	385			500	350	1,070	735
New York	2,929,488	1,647,210	518,981	282,133	1,085,679	643,822	4,534,148	2,573,165
North Carolina	146,436	123,954	52,433	33,612	32,560	27,333	231,429	184,899
Ohio	2,834,076	1,477,429	826,649	354,505	557,045	285,316	4,217,770	2,117,250
Oklahoma	4,000	2,000	206,111	107,574	204,483	132,101	414,594	241,675
Oregon	175,058	158,051			4,815	6,718	179,873	164,769
Pennsylvania	1,414,652	930,812	1,055,043	579,480	909,745	604,137	3,379,440	2,114,429
Rhode Island	25,618	27,476			3,433	3,838	29,051	31,314
South Carolina	35,000	30,300	33,000	27,500	38,000	35,000	106,000	92,800
South Dakota	7,500	6,000			3,000	2,500	10,500	8,500
Tennessee	322,213	202,416	131,794	56,439	107,278	60,350	561,285	319,205
Texas	115,732	110,058	207,180	122,360	17,402	13,066	340,314	245,484
Utah	59	14	250	125	150	263	459	402
Vermont	15,775	17,916	1,250	1,000	2,070	2,535	19,095	21,451
Virginia	81,420	51,829	222,921	117,245	183,215	129,540	487,556	298,614
Washington	37,129	29,616			2,849	2,280	39,978	31,896
West Virginia	145,393	73,979	408,268	199,899	62,341	35,152	616,002	309,030
Wisconsin	787,823	541,048	72,335	47,363	401,492	263,063	1,261,650	851,474
Wyoming					3,225	2,430	3,225	2,430
Total	17,170,900	10,717,981	7,126,562	3,716,966	8,973,740	5,827,065	33,271,202	20,262,012

Production of crushed stone in 1908 and 1909, by States and Territories, and by uses, in short tons—Continued.

1909.

State or Territory.	Road making.		Railroad ballast.		Concrete.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Alabama	90,715	$60,452	13,246	$5,521	95,623	$68,257	199,584	$134,230
Arizona			2,460	2,055	64,242	51,203	66,702	53,258
Arkansas	96,169	79,404	21,265	14,995	35,637	25,525	153,071	119,924
California	1,656,539	1,262,035	314,528	179,941	674,944	466,189	2,646,011	1,908,165
Colorado	200	100			18,680	13,784	18,880	13,884
Connecticut	492,837	300,285	58,815	28,905	87,663	57,121	639,315	386,311
Delaware	24,000	20,105	154,918	98,485	31,600	30,337	210,518	148,927
Florida	2,150	4,150			1,500	3,000	3,650	7,150
Georgia	27,575	17,154	87,373	60,955	120,393	86,600	235,341	164,709
Hawaii	41,723	41,039			32,000	25,000	73,723	66,039
Idaho	14,047	13,608					14,047	13,608
Illinois	1,354,310	1,238,533	1,094,708	422,859	2,409,397	1,249,783	4,858,415	2,911,175
Indiana	1,177,536	627,289	138,781	54,086	116,527	54,449	1,432,844	735,824
Iowa	143,009	116,346	24,418	16,329	350,343	246,054	517,770	378,729
Kansas	206,965	155,294	500,803	257,654	264,139	207,405	971,907	620,353
Kentucky	406,162	273,456	690,260	291,266	66,463	47,364	1,162,885	612,086
Louisiana			3,211	2,569	11,679	9,343	14,890	11,912
Maine	11,897	10,786	300	330	10,086	7,849	22,283	18,965
Maryland	315,681	247,095	101,470	58,647	256,367	219,669	673,518	525,411
Massachusetts	580,548	443,161	173,475	83,564	476,802	372,747	1,230,825	899,472
Michigan	241,751	139,588	91,914	46,649	268,309	117,897	601,974	304,134
Minnesota	187,188	157,993	176,015	60,345	239,532	198,970	602,735	417,308
Missouri	746,016	558,249	154,486	87,445	456,701	370,294	1,357,203	1,015,988
Montana					28,000	15,400	28,000	15,400
Nebraska	82,090	83,147	37,524	31,898	141,307	118,523	260,921	233,568
New Hampshire	21,841	21,429			12,200	9,360	34,041	30,789
New Jersey	862,193	705,327	279,596	183,094	321,174	247,832	1,462,963	1,136,253
New Mexico	3,125	3,750	489,200	263,081	5,850	3,150	498,175	269,981
New York	2,726,133	1,490,872	1,013,755	454,185	1,131,143	626,422	4,871,031	2,571,479
North Carolina	64,348	76,117	56,154	28,151	119,979	101,866	240,481	206,134
Ohio	2,892,292	1,533,651	880,454	341,669	536,486	262,029	4,309,232	2,137,349
Oklahoma	8,920	5,491	274,690	148,589	428,320	291,313	711,930	445,393
Oregon	244,472	206,372	900	1,025	7,781	9,480	253,153	216,877
Pennsylvania	1,598,666	988,409	1,624,697	855,775	1,319,868	784,163	4,543,231	2,628,347
Rhode Island	86,231	99,358	2,450	2,617	15,150	17,125	103,831	119,100
South Carolina	14,820	10,672	19,677	15,827	34,872	32,834	69,369	59,333
South Dakota	6,250	7,000	14,000	12,600	20,430	20,494	40,680	40,094
Tennessee	372,016	245,445	227,568	95,665	120,668	72,706	720,252	413,816
Texas	239,115	169,045	6,680	3,400	41,910	36,007	287,705	208,452
Utah					50	25	50	25
Vermont	11,960	9,437	1,000	1,000	5,160	4,362	18,120	14,799
Virginia	110,035	105,630	500,572	237,061	195,729	155,880	806,336	498,571
Washington	101,818	89,093					101,818	89,093
West Virginia	135,354	60,007	693,949	324,178	74,667	50,946	903,970	435,131
Wisconsin	743,982	539,038	145,973	79,803	352,240	222,393	1,242,195	841,234
Total	18,142,679	12,215,412	10,071,285	4,852,218	11,001,611	7,011,150	39,215,575	24,078,780

According to this table the following seven States in the order named were the largest producers of crushed stone: Illinois, Pennsylvania, New York, Ohio, California, New Jersey, and Missouri. Each of these States produced crushed stone valued at more than $1,000,000.

The following table shows the quantity and value of crushed stone produced in the United States in 1908 and 1909, by uses and kinds of stone:

Quantity and value of crushed stone produced in the United States in 1908 and 1909, by kinds and uses, in short tons.

1908.

Kind.	Road making.		Railroad ballast.		Concrete.		Total.		Average price per ton.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
Granite	1,429,814	$1,207,666	693,020	$384,215	976,808	$853,387	3,099,642	$2,445,268	$0.79
Traprock	3,386,415	2,313,693	1,121,769	682,875	1,550,010	1,005,652	6,058,194	4,002,220	.66
Limestone	11,910,760	6,880,893	5,095,109	2,530,738	5,907,625	3,496,576	22,913,494	12,908,207	.56
Sandstone	443,911	315,729	216,664	119,138	539,297	471,450	1,199,872	906,317	.76
Total	17,170,900	10,717,981	7,126,562	3,716,966	8,973,740	5,827,065	33,271,202	20,262,012	
Average price	....	.62	....	.52	....	.65	....	.61	

1909.

Kind.	Road making.		Railroad ballast.		Concrete.		Total.		Average price per ton.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
Granite	1,743,326	$1,488,711	1,118,580	$660,632	1,046,560	$914,667	3,908,466	$3,064,010	$0.78
Trap rock	4,493,403	3,038,622	1,063,561	600,039	1,739,595	1,110,425	7,296,559	4,749,086	.65
Limestone	11,413,794	7,294,248	7,273,100	3,308,430	7,605,871	4,450,075	26,292,765	15,052,753	.57
Sandstone	492,156	393,831	616,044	283,117	609,585	535,983	1,717,785	1,212,931	.71
Total	18,142,679	12,215,412	10,071,285	4,852,218	11,001,611	7,011,150	39,215,575	24,078,780	
Average price	....	.67	....	.48	....	.64	....	.61	

As shown by this table the quantity and value of the crushed stone output in 1909 was 39,215,575 short tons, valued at $24,078,780, an increase of 5,944,373 tons in quantity and of $3,816,765 in value over the output in 1908. The average price per ton—61 cents—was the same as in 1908. Crushed granite increased 808,824 tons in quantity and $618,742 in value. The average price per ton decreased from 79 cents in 1908 to 78 cents in 1909.

Crushed trap rock increased 1,238,365 short tons in quantity and $746,866 in value. The average price per ton declined from 66 cents in 1908 to 65 cents in 1909.

Crushed limestone increased 3,379,271 short tons in quantity and $2,144,546 in value. The average price per ton increased from 56 cents in 1908 to 57 cents in 1909.

Crushed sandstone increased 517,913 short tons in quantity and $306,614 in value. The average price per ton was 76 cents in 1908 and 71 cents in 1909.

Crushed stone used for road making increased 971,779 short tons in quantity and $1,497,431 in value. The average price per ton increased from 62 cents in 1908 to 67 cents in 1909.

Crushed stone for railroad ballast increased 2,944,723 short tons in quantity and $1,135,252 in value. The average price per ton decreased from 52 cents in 1908 to 48 cents in 1909.

Crushed stone for concrete increased 2,027,871 short tons in quantity and $1,184,085 in value. The average price per ton declined from 65 cents per ton in 1908 to 64 cents per ton in 1909.

EXPORTS AND IMPORTS.

The following figures, compiled from statistics furnished by the Bureau of Statistics of the Department of Commerce and Labor, give the value of the exports and imports of stone for the calendar years 1908 and 1909:

Exports of stone from the United States in 1908 and 1909.

Kind.	1908.	1909.
Marble and stone, unmanufactured	$249,184	$335,020
All others	754,067	835,799
Total	1,003,251	1,170,819

Imports of stone into the United States in 1908 and 1909.

Kind.	1908.	1909.	Kind.	1908.	1909.
Marble:			Granite:		
In block, rough, etc	$881,099	$1,013,458	Dressed	$187,229	$182,066
Sawed or dressed	2,428	14,832	Rough	6,184	8,352
Slabs or paving tiles	89,371	58,562	Total	193,413	190,418
All other manufactures	130,751	204,557			
Mosaic cubes	35,053	33,582	Stone (other):		
			Dressed	12,345	45,662
Total	1,138,702	1,324,991	Rough	55,765	17,447
Onyx:			Total	68,110	63,109
In block, rough, etc	71,979	81,787	Grand total	1,483,026	1,663,025
All other manufactures	9,822	2,720			
Total	81,801	84,507			

These tables show an increase of $167,568 in the value of the exports of stone during 1909 and an increase of $179,999 in the value of the imports. Both imports and exports decreased in value from 1907 to 1908.

GRANITE.

PRODUCTION.

The figures given in this report as representing the value of the granite production in the United States include also the values of small quantities of gneiss, mica schist, lava, tuff, trachyte, andesite, syenite, quartz porphyry, basalt, and other igneous rocks. The quantities of these allied rocks quarried are too small to tabulate separately. The quarrying of trap rock, consisting largely of basalt, in the States of California, Connecticut, Massachusetts, New Jersey, New York, and Pennsylvania, however, represents an industry sufficient by itself to make it advisable to tabulate this stone separately, and its value is not included in the grand total of granite.

The value of the granite produced in the United States in 1909 was $19,581,597, an increase of $1,161,517 as compared with $18,420,080, the value in 1908. This represents an increase of 6.3 per cent, which is the largest recorded in the granite industry during the last six years.

Granite for building purposes—rough, rubble, and dressed—rough granite for monumental work, granite for paving blocks, curbing, crushed granite for roads, railroad ballast, and concrete, and for miscellaneous purposes, increased in value; granite sold dressed for monumental work and granite sold for flagging and riprap showed a slight decrease. Fourteen States produced granite valued at more than $500,000 in 1909 in the following order: Vermont, Massachusetts, Maine, Wisconsin, California, New Hampshire, Rhode Island, Georgia, Maryland, North Carolina, Washington, Minnesota, Connecticut, and Pennsylvania. Of these States the first six produced granite valued at more than $1,000,000. All of them showed an increase except Maine, Wisconsin, California, Georgia, North Carolina, and Washington.

The following table shows the value of the production of granite, including a small output of other igneous rocks, in the United States from 1905 to 1909, inclusive:

Value of granite, etc., produced in the United States, by States and Territories, 1905–1909.

State or Territory.	1905.	1906.	1907.	1908.	1909.
Arizona	$3,700	$32,042	$13,700	$8,544	(a)
Arkansas	90,312	118,903	168,996	152,567	$150,179
California	1,161,330	740,784	1,306,324	1,684,504	1,310,520
Colorado	73,802	65,402	67,134	121,282	74,326
Connecticut	636,364	974,024	591,153	592,904	610,514
Delaware	178,428	146,346	158,192	195,761	456,328
Georgia	971,207	792,315	858,603	970,832	843,542
Hawaii	33,550	23,346	19,599	81,219	68,955
Idaho	1,500	400	25,942	(a)	(a)
Maine	2,713,795	2,560,021	2,146,420	2,027,508	1,939,524
Maryland	957,048	883,881	1,183,753	762,442	771,224
Massachusetts	2,251,319	3,327,416	2,328,777	2,027,463	2,164,619
Michigan					} [b] 660,823
Minnesota	481,908	626,069	546,603	629,427	}
Missouri	180,579	150,009	136,405	157,968	155,717
Montana	126,430	114,005	102,050	(a)	(a)
Nevada					
New Hampshire	838,371	818,131	647,721	867,028	1,215,461
New Jersey	76,758	101,224	75,757	125,804	60,175
New Mexico			167,294		(a)
New York	134,425	304,048	289,722	367,066	443,910
North Carolina	564,578	778,847	889,976	764,272	743,876
Oklahoma	20,720	18,847	24,550	23,239	67,584
Oregon	85,330	58,961	117,625	271,869	284,135
Pennsylvania	450,619	349,453	366,679	324,241	507,814
Rhode Island	556,364	622,812	674,148	556,474	933,053
South Carolina	297,284	247,998	129,377	297,874	218,045
South Dakota			690	(a)	
Texas	132,193	168,061	122,158	190,055	173,271
Utah	13,630	4,948	5,240	5,229	7,525
Vermont	2,571,850	2,934,825	2,693,889	2,451,933	2,811,744
Virginia	452,390	340,900	398,426	321,530	488,250
Washington	681,730	459,975	562,352	870,944	742,878
Wisconsin	825,625	798,213	1,228,863	1,529,781	1,442,305
Wyoming		600	90	(a)	
Other States				40,320	[c] 235,300
Total	17,563,139	18,562,806	18,064,708	18,420,080	19,581,597

[a] Included in other States.
[b] Includes a small value for trap rock in Michigan and Minnesota.
[c] Includes Arizona, Idaho, Montana, and New Mexico.

The following table shows the value of the granite, including small values for trap and other igneous rocks, produced in the United States in 1908 and 1909, by States and Territories and by uses.

Value of granite and other igneous rocks produced in the United States in 1908 and 1909, by States and Territories and uses.

1908.

State or Territory.	Sold in the rough.					Dressed for building.	Dressed for monumental work.	Made into paving blocks.
	Building.	Monumental.	Rubble.	Riprap.	Other.			
Arizona	$5,844					$100	$2,500	
Arkansas	100		$29,476	$22,635			40	
California	58,743	$44,694	51,833	164,323	$80,146	719,833	53,784	$66,079
Colorado	6,495	27,353			850	50,000	36,584	
Connecticut	33,833	23,218	210,170	92,931	8,051	117,242	58,672	14,951
Delaware	1,228		35,571	1,349		947	12,492	6,050
Georgia	60,850	27,450	119,516	36,000	1,300	125,350	9,500	135,510
Hawaii				900				
Maine	293,371	63,799	6,726	12,326	8,382	1,055,989	111,774	368,715
Maryland	119,094	6,824	60,359	7,751	11,600	48,407	3,273	71,316
Massachusetts	180,063	358,830	106,461	8,733	50,436	720,796	115,386	261,880
Minnesota	55,243	33,600	18,490	34,056	3,050	34,453	346,389	35,750
Missouri	728	35,455		3,771	240	12,500		75,320
New Hampshire	92,738	111,253	7,865	3,482	2,300	355,628	136,772	103,833
New Jersey	11,910	8,869	150	600	1,050	5,548	8,550	2,674
New York	11,441	7,166	15,119	733	1,200	63,276	14,625	98,273
North Carolina	109,919	29,822	4,933	730		144,261	46,834	122,488
Oklahoma	400	3,300	2,000			10,400	3,000	400
Oregon	12,973	940	709	600	1,205	5,428	45,000	40,000
Pennsylvania	164,008	6,172	6,674	14,696	173	38,531	3,066	23,628
Rhode Island	5,272	149,638	393	421	820	71,613	262,376	29,651
South Carolina	12,699	52,565	9,475	73,984	45	12,012	18,697	12,277
Texas	13,790	42,026	25	63,974		2,109	51,280	300
Utah	917	2,900		75		337	1,000	
Vermont	79,711	1,095,223	385		3,472	676,067	582,051	1,547
Virginia	26,769	12,664	18,270	16,336	1,000	11,500	22,303	10,173
Washington	11,151	29,620	7,432	672,278		37,702	41,294	255
Wisconsin	9,271	45,838	5,488			34,123	337,200	939,485
Other States	545	7,400	600		875	18,000		
Total	1,379,106	2,226,619	718,120	1,232,684	176,195	4,372,152	2.324,442	2,420,555

State or Territory.	Curbing.	Flagging.	Crushed stone.			Other.	Total.
			Road making.	Railroad ballast.	Concrete.		
Arizona			$100				$8,544
Arkansas	$945		6,500		$92,771	$100	152,567
California	123,568		178,073	$41,470	101,612	346	1,684,504
Colorado							121,282
Connecticut	25,324	$999	2,000		3,890	1,623	592,904
Delaware	5,579	96	69,462	37,065	25,922		195,761
Georgia	346,383	36,000	2,500	9,543	50,518	10,412	970,832
Hawaii			22,035		49,219	9,065	81,219
Maine	75,247	7,558	2,557	150	9,818	11,096	2,027,508
Maryland	26,003	3,869	206,505	32,923	143,838	20,680	762,442
Massachusetts	91,430	2,897	82,501	9,268	33,942	4,840	2,027.463
Minnesota	17,462	1,954	10,141	17,000	21,149	690	629,427
Missouri			6,051		15,741	8,162	157,968
New Hampshire	35,379	520	6,329		10,126	803	867,028
New Jersey			8,200	72,195	6,058		125,804
New York	2,400		102,040	28,837	21,906	50	367,066
North Carolina	99,070	8,258	114,474	33,612	27,333	22,538	764,272
Oklahoma	2,000			39	1,700		23,239
Oregon	225		158,051		6,718	20	271,869
Pennsylvania	11,259	586	28,261	1,909	11,595	13,683	324,241
Rhode Island	577	399	27,476		3,838	4,000	556,474
South Carolina	11,670	100	30,300	27,500	35,000	1,550	297,874
Texas	12,750		1,080		2,721		190,055
Utah							5,229
Vermont	3,836		8,641	1,000			2,451,933
Virginia	6,130		21,670	71,704	102,936	75	321,530
Washington	38,035		29,616		1,821	1,740	870,944
Wisconsin	5,350	5,508	76,703		70,815		1,529.781
Other States	2,100	2,000	6,400		2,400		40,320
Total	942,722	70,744	1,207,666	384,215	853,387	111,473	18,420,080

Value of granite and other igneous rocks in the United States in 1908 and 1909, by States and Territories and uses—Continued.

1909.

State or Territory.	Sold in the rough.					Dressed for building.	Dressed for monumental work.	Made into paving blocks.
	Building.	Monumental.	Rubble.	Riprap.	Other.			
Arkansas	$1,000		$9,522	$68,000		$799	$120	
California	30,536	$39,579	12,798	109,847	$2,875	432,551	97,978	$34,470
Colorado	15,267	28,451	4,950	18	1,200	24,000		
Connecticut	25,097	35,867	5,342	112,830	1,382	274,501	66,538	8,698
Delaware	9,769		1,557	280,488		2,043		9,084
Georgia	39,685	28,174	33,216	59,245		120,270	2,693	93,300
Hawaii	3,100							
Maine	237,597	31,375	14,685	14,090	26,271	1,152,677	39,704	262,895
Maryland	120,561	8,471	70,479	6,695	4,450	114,002	2,675	93,742
Massachusetts	212,075	508,805	51,658	2,462	17,752	542,441	298,235	308,203
Minnesota	43,659	76,636	48,210	1,093		144,997	167,088	66,605
Missouri	4,093	46,750		3,878		5,930	2,300	46,163
New Hampshire	143,757	70,018	23,387	4,367	200	521,299	192,762	170,434
New Jersey	7,366	1,000	150	200	942	1,133	50	2,250
New York	35,399	1,864	17,639	5,421	2,971	17,193	23,903	250,070
North Carolina	56,859	11,682	5,803	34		142,778	38,192	214,508
Oklahoma	1,471	16,541	13,050	8,000		15,408	5,691	
Oregon	6,996	5,460				2,321	16,129	37,348
Pennsylvania	306,466	10,400	4,751		1,950	53,529		15,840
Rhode Island	45,501	176,565	1,510		73	218,089	314,237	52,004
South Carolina	67,877	5,215	19,680	53,037	1,755	1,000		4,284
Texas	29,530	36,082		22,141	2,875	36,612	11,400	
Utah	996	4,396					2,133	
Vermont	128,233	1,154,826	1,037	4,100	100	1,035,075	479,415	5,824
Virginia	24,965	1,966	33,321	1,386		17,750	9,449	18,053
Washington	11,478	6,308	423,230	18,408		17,185	19,902	66,544
Wisconsin	300	26,984	420			5,154	212,043	982,798
Other States[d]	2,502	8,940	1,000			22,000	3,000	
Total	1,612,135	2,342,355	797,395	775,740	64,796	4,920,737	2,005,637	7,243,117

State or Territory.	Curbing.	Flagging.	Crushed stone.			Other.	Total.
			Road-making.	Railroad ballast.	Concrete.		
Arizona							(a)
Arkansas	$300		$68,338	$1,470	$630		$150,179
California	163,012	$375	262,077	57,064	65,020	$2,338	1,310,520
Colorado						440	74,326
Connecticut	45,573	250	7,831		23,752	2,850	610,514
Delaware	3,960		20,105	98,485	30,337	500	456,328
Georgia	318,957	240	16,405	46,864	83,497	996	843,542
Hawaii			40,855		25,000		68,955
Idaho							(a)
Maine	74,739	13,770	10,786	330	7,849	52,756	1,939,524
Maryland	3,474	2,427	138,465	38,576	158,468	8,739	771,224
Massachusetts	113,705	3,666	56,805	8,533	36,344	3,935	2,164,619
Michigan							(b)
Minnesota	8,154	150	40,221	26,220	36,540	1,250	c 660,823
Missouri			15,345		31,258		155,717
Montana							(a)
New Hampshire	53,038	635	21,429		9,360	4,775	1,215,461
New Jersey				44,960	2,124		60,175
New Mexico							(a)
New York	1,352		52,263	2,600	33,235		443,910
North Carolina	98,153	1,233	44,617	28,151	101,866		743,876
Oklahoma	2,000				3,500	1,923	67,584
Oregon		3,004	206,372	1,025	5,480		284,135
Pennsylvania	8,401	3,490	41,047	5,625	39,004	17,311	507,814
Rhode Island	5,955		99,358	2,617	17,125	19	933,053
South Carolina	3,554	125	10,672	15,827	32,834	2,185	218,045
Texas	1,100		32,584		947		173,271
Utah							7,525
Vermont	1,319		765	1,000		50	2,811,744
Virginia	29,100	990	74,054	125,704	147,112	4,400	488,250
Washington	76,574		88,868			14,381	742,878
Wisconsin	3,048	16,875	125,838		23,385	45,460	1,442,305
Other States[d]	15,100		13,608	155,581		13,569	235,300
Total	1,030,568	47,230	1,488,711	660,632	914,667	177,877	19,581,597

[a] Included in "Other States."
[b] A small value for trap rock included in Minnesota.
[c] Includes a value of trap rock for Michigan and Minnesota.
[d] "Other States" includes Arizona, Idaho, Montana, and New Mexico.

The following table shows the quantity and value of granite paving blocks produced in the United States in 1908 and 1909, by States:

Number and value of granite paving blocks produced in 1908 and 1909, by States and Territories.

State or Territory.	Paving blocks.			
	1908.		1909.	
	Number.	Value.	Number.	Value.
California	1,657,600	$66,079	817,500	$34,470
Connecticut	292,485	14,951	180,130	8,698
Delaware	121,000	6,050	187,095	9,084
Georgia	4,735,770	135,510	3,384,600	93,300
Maine	8,005,662	368,715	6,137,682	262,895
Maryland	692,538	71,316	1,107,149	93,742
Massachusetts	6,134,648	261,880	6,878,872	308,203
Minnesota	532,750	35,750	974,000	66,605
Missouri	1,826,742	75,320	1,150,914	46,163
New Hampshire	2,842,206	103,833	4,997,161	170,434
New Jersey	96,956	2,674	30,000	2,250
New York	1,573,777	98,273	3,571,997	250,070
North Carolina	3,679,745	122,488	5,062,500	214,508
Oklahoma	5,900	400		
Oregon	1,000,000	40,000	936,260	37,348
Pennsylvania	529,037	23,628	374,171	15,840
Rhode Island	567,416	29,651	1,051,681	52,004
South Carolina	351,250	12,277	106,204	4,284
Texas	6,000	300		
Vermont	58,200	1,547	163,885	5,824
Virginia	358,664	10,173	853,300	18,053
Washington	3,000	255	1,109,072	66,544
Wisconsin	13,399,882	939,485	18,798,977	982,798
Total	48,471,228	2,420,555	57,873,150	2,743,117
Average price per thousand		49.94		47.40

This table shows a large increase—9,401,922 blocks and $322,562—in the number and value of the paving blocks cut in the United States in 1909, and calls attention to the rapid increase in the use of granite blocks for street pavements in large cities. A large proportion of the output of Wisconsin, the largest producing State, goes to Chicago; the blocks for New York and other large eastern cities are supplied by Massachusetts, Maine, New York, North Carolina, New Hampshire, New Jersey, Georgia, and other granite-producing States near the Atlantic seaboard, and the Pacific coast demand is met by the quarries in the States situated on that coast. The average price per thousand at the original points of shipment was $47.40 in 1909, a decrease of $2.54 as compared with the price in 1908.

GRANITE PRODUCTION OF VERMONT.

A more detailed statement of the granite production of Vermont is of interest here since Vermont at present produces more granite than any other State and since the granite industry is one of the principal sources of its wealth.

The following table shows the production of granite in Vermont in 1908, and 1909, by counties and uses:

Production of granite in Vermont in 1908 and 1909, by counties and uses.

1908.

County.	Number of firms reporting.	Building.			
		Rough.		Dressed.	
		Quantity (cubic feet).	Value.	Quantity (cubic feet).	Value.
Washington and Orange	39	15,896	$9,871	129,230	$429,967
Windsor	3	63,537	59,054	52,866	244,850
Caledonia and Orleans	9	12,753	3,999	....	....
Windham	3	12,050	6,787	1,225	1,250
Total	54	104,236	79,711	173,321	676,067
Average price per cu. ft	....	....	.76	....	3.90

County.	Monumental.				Paving.		Other purposes.	Total value.
	Rough.		Dressed.					
	Quantity (cubic feet).	Value.	Quantity (cubic feet).	Value.	Quantity (number of blocks).	Value.	Value.	
Washington and Orange	1,094,619	$1,015,006	164,706	$576,551	50,400	$1,262	$14,443	$2,047,100
Windsor	12,000	6,000	....	....	....	....	....	309,904
Caledonia and Orleans	117,560	66,580	1,000	5,000	....	....	2,175	77,754
Windham	11,750	7,637	200	500	7,800	285	716	17,175
Total	1,235,929	1,095,223	165,906	582,051	58,200	1,547	17,334	2,451,933
Average price per cu. ft	....	.89	....	3.51	....	....	....	....

1909.

County.	Number of firms reporting.	Building.			
		Rough.		Dressed.	
		Quantity (cubic feet).	Value.	Quantity (cubic feet).	Value.
Washington and Orange	34	44,020	$17,457	381,730	$1,034,575
Windsor	3	111,020	88,816		
Caledonia and Essex	10	45,000	17,285	500	500
Windham	3	12,950	4,550	....	....
Orleans	3	750	125	....	....
Total	53	213,740	128,233	382,230	1,035,075
Average price per cu. ft	....	....	.60	....	2.71

Production of granite in Vermont in 1908 and 1909, by counties and uses—Continued.

1909—Continued.

County.	Monumental.				Paving.		Other purposes.	Total value.
	Rough.		Dressed.					
	Quantity (cubic feet).	Value.	Quantity (cubic feet).	Value.	Quantity (number of blocks).	Value.	Value.	
Washington and Orange	1,210,696	$1,094,616	173,242	$478,349	29,885	$897	$8,161	$2,297,910
Windsor								424,961
Caledonia and Essex	94,962	44,789						62,574
Windham	233	233	100	250	134,000	4,927	110	10,070
Orleans	37,943	15,188	400	816			100	16,229
Total	1,343,834	1,154,826	173,742	479,415	163,885	5,824	8,371	2,811,744
Average price per cu. ft		.86		2.76				

TRAP ROCK.

Besides the trap rock given in the following tables there is a small quantity included in the figures for granite under those States in which trap rock does not form enough of an industry to warrant the separate publication of the figures. The trap rock industry in the Pacific coast States is known as the basalt quarrying industry.

The total output of trap rock in 1909 was valued at $5,133,842, as compared with $4,282,406 in 1908, an increase of $851,436. Every State showed an increase except Connecticut. The principal increases were in the values of trap rock used for paving, road making and concrete work, although there was a large increase reported in unclassified uses. The value of trap rock used in building and in railroad ballasting decreased slightly.

California, as in 1907, showed the largest value of trap rock products, the large increase over 1908 being due to the quantities crushed for road making. New Jersey ranked second, with a large increase also in the value of rock crushed for road making.

The following table shows the value of the trap rock output in the United States in 1908 and 1909, by States and uses:

Value of trap produced in the United States in 1908 and 1909, by States and uses.

1908.

State.	Building.	Paving.	Crushed stone.			Other.	Total.
			Road-making.	Railroad ballast.	Concrete.		
California	$722	$114,996	$423,798	$148,154	$285,380	$6,089	$979,139
Connecticut	7,594	8,125	199,540	100,000	152,950	5,010	473,219
Massachusetts	12,235		348,108	30,695	117,134	500	508,672
New Jersey	11,399	58,169	578,570	182,355	235,967	13,054	1,079,514
New York			567,908	20,580	107,234	28,231	723,953
Pennsylvania	8,593	2,835	195,769	201,091	106,987	2,634	517,909
Total	40,543	184,125	2,313,693	682,875	1,005,652	55,518	4,282,406

Value of trap produced in the United States in 1908 and 1909, by States and uses—Con.

1909.

State.	Building.	Paving.	Crushed stone.			Other.	Total.
			Road-making.	Railroad ballast.	Concrete.		
California	$900	$129,764	$799,846	$71,108	$361,255	$108,212	$1,471,085
Connecticut	6,827	2,720	292,451	28,905	33,369	3,383	367,655
Massachusetts	13,250	....	337,839	75,031	247,382	....	673,502
New Jersey	1,496	92,379	664,571	138,134	232,262	11,729	1,140,571
New York	....	....	662,448	27,620	70,708	....	760,776
Pennsylvania	11,056	1,800	281,467	259,241	165,449	1,240	720,253
Total	33,529	226,663	3,038,622	600,039	1,110,425	124,564	5,133,842

The following table shows the quantity and value of trap paving blocks produced in the United States in 1908 and 1909, by States:

Number and value of trap paving blocks produced in the United States, 1908–9, by States.

State.	Paving blocks.			
	1908.		1909.	
	Number.	Value.	Number.	Value.
California	2,765,587	$114,996	3,060,078	$129,764
Connecticut	232,160	8,125	80,590	2,720
New Jersey	1,665,983	58,169	2,105,720	92,379
Pennsylvania	63,000	2,835	50,000	1,800
Total	4,726,730	184,125	5,296,388	226,663
Average price per thousand	....	38.95	....	42.80

SANDSTONE.

PRODUCTION.

Total value.—The value of sandstone increased from $7,594,091 in 1908 to $8,010,454, or $416,363. This is the first increase in the value of sandstone production in the last seven years, but the total does not reach that for 1907, which was the last normal business year. The industry of quarrying sandstone can not therefore be said to be showing any marked improvement at present, except in localities producing the highest grade stone and having an established trade. The leading sandstone-producing States in 1909 were Ohio, Pennsylvania, and New York, in the order named. Of these, New York showed a decrease in production. In the two States, Washington and Arizona, which showed a marked increase in 1908, there was a considerable decrease in 1909.

In New York and Pennsylvania a part of the sandstone output is known to the trade as bluestone, the production of which is given in a separate table.

The following table shows the value of the sandstone production in the United States from 1905 to 1909, inclusive, by States and Territories:

Value of sandstone (including quartzite) production in the United States, 1905–1909, by States and Territories.

State or Territory.	1905.	1906.	1907.	1908.	1909.
labama	$28,107	$40,467	$48,673	$34,099	$77,327
rizona	65,558	33,149	158,435	396,358	298,335
rkansas	58,161	55,703	94,275	42,463	67,956
alifornia	685,668	642,166	437,738	330,214	290,034
olorado	453,029	286,544	299,443	181,051	197,105
onnecticut	62,618	(a)	(a)	55,949	(b)
daho	22,265	11,969	24,001	33,394	29,263
llinois	29,115	19,125	14,996	12,218	26,891
ndiana	15,421	30,740	15,425	3,342	4,119
owa	9,335	5,600	3,542	2,337	2,443
ansas	79,617	42,809	46,831	67,950	19,560
entucky	280,579	125,123	98,450	78,732	90,835
aryland	12,984	9,533	13,859	6,262	10,584
assachusetts	367,461	260,721	243,323	241,462	c 457,962
ichigan	123,123	65,395	53,003	39,103	36,084
innesota	294,640	285,433	300,204	197,184	299,358
issouri	27,686	20,951	35,289	17,954	28,763
ontana	45,116	37,462	39,216	51,564	73,443
ebraska	120	6,899	11,609	d 15,815	....
evada	1,500	....	....	(e)	(f)
ew Jersey	294,719	215,142	177,667	154,422	189,098
ew Mexico	101,522	42,574	12,450	g 10,410	4,963
ew York	h 1,831,756	hc 1,905,892	hc 1,978,117	h 1,774,843	h 1,430,830
orth Carolina	4,483	3,531	4,105	i 12,266	....
orth Dakota	1,055	44	3,260	(j)	(k)
hio	1,744,472	1,426,645	1,591,148	1,244,752	1,639,006
klahoma	15,112	40,861	43,403	57,124	59,855
regon	1,229	25,950	3,904	(j)	g 4,811
ennsylvania	h 2,487,939	h 2,724,874	h 2,064,913	h 1,368,784	h 1,637,794
outh Dakota	193,408	145,966	143,585	128,554	l 118,029
ennessee	8,715	14,136	16,523	(m)	(n)
exas	123,281	111,533	108,047	154,948	61,600
tah	43,429	137,529	24,298	25,097	71,235
irginia	2,000	5,100	(n)	(m)	28,574
Vashington	124,910	169,500	295,585	464,587	335,470
Vest Virginia	171,309	113,369	o 197,926	127,149	p 201,038
Visconsin	161,741	181,986	236,183	219,130	204,959
Vyoming	33,591	24,715	32,252	44,574	13,130
Total	10,006,774	9,169,337	8,871,678	7,594,091	8,010,454

a Included in New York.
b Included in Massachusetts.
c Includes Connecticut.
d Includes North Dakota and Oregon.
e Included with New Mexico.
f Included in Oregon.
g Includes Nevada.
h Includes bluestone.
i Includes Tennessee and Virginia.
j Included with Nebraska.
k Included in South Dakota.
l Includes North Dakota.
m Included with North Carolina.
n Included in West Virginia.
o Includes a small value for Virginia.
p Includes Tennessee.

The following table shows the value of the sandstone, including quartzite, production of the United States in 1908 and 1909, by States and Territories, and uses:

Value of sandstone (including quartzite) production in the United States in 1908 and 1909, by States and Territories and uses.

1908.

State or Territory.	Rough building.	Dressed building.	Ganister.	Paving.	Curbing.	Flagging.	Rubble.
Alabama							$3,450
Arizona	$4,600	$6,500				$38	378,500
Arkansas	4,158	850			$13,800	625	2,650
California	26,326	79,050			4,925	700	9,505
Colorado	56,767	17,534	$14,861	$14,895	13,480	32,510	23,668
Connecticut	5,901	50,048					
Idaho	13,605	11,932					7,857
Illinois	6,174	3,265	700	75			538
Indiana	500	150			200	192	2,300
Iowa	1,737						460
Kansas	12,780	500			15,265	16,020	300
Kentucky	29,337	46,699		275	15	300	1,560
Maryland	2,850	106	2,419				
Massachusetts	59,229	52,300					3,150
Michigan	15,100	18,813					5,190
Minnesota	5,795	25,693		81,104	24,129	1,849	28,859
Missouri	2,820	7,556			52	292	1,772
Montana	40,755	3,674					3,830
Nebraska	7,016	3,419				100	525
Nevada							
New Jersey	72,693	28,905			250	2,900	22,998
New Mexico	900	1,230			50	580	7,122
New York	217,968	270,853		231,789	420,404	456,091	2,230
North Carolina	4,000	6,600					1,250
North Dakota							
Ohio	157,074	282,370	1,575	7,000	330,045	326,593	19,819
Oklahoma	8,149	960			50	100	7,033
Oregon							
Pennsylvania	136,084	362,388	111,870	16,310	199,800	226,940	66,470
South Dakota	46,093	9,875		48,700	250	360	7,893
Tennessee							
Texas	11,490	33,300			1,200		6,290
Utah	13,117	100		5,775	75		5,705
Virginia							
Washington	1,375	99,656		248,973			1,062
West Virginia	37,941	32,393			1,269	1,144	27,123
Wisconsin	82,705	27,460	43,900				14,458
Wyoming	23,563	12,600					6,201
Total	1,108,602	1,496,779	175,325	654,896	1,025,259	1,067,334	669,768

alue of sandstone (including quartzite) production in the United States in 1908 and 1909, by States and Territories and uses—Continued.

1908—Continued.

State or Territory.	Riprap.	Crushed stone.			Other.	Total.
		Road making.	Railroad ballast.	Concrete.		
labama	$20,599			$10,000	$50	$34,099
rizona			$2,500	4,220		396,358
rkansas	3,725	$250		16,400	5	42,463
alifornia	3,050	92,306	8,427	103,955	1,970	330,214
olorado	40			6,210	1,086	181,051
onnecticut						55,949
laho						33,394
linois	122	1,200			144	12,218
ndiana						3,342
owa	65			40	35	2,337
ansas		18,750		3,985	350	67,950
entucky	100			446		78,732
aryland	363			524		6,262
assachusetts	1,025	25,804		97,254	2,700	241,462
ichigan						39,103
innesota	4,755	8,204	7,404	8,392	1,000	197,184
issouri	4,900				562	17,954
ontana	2,931				374	51,564
ebraska	4,755					[a] 15,815
evada						([b])
ew Jersey		4,260		22,316	100	154,422
ew Mexico	75	253			200	[c] 10,410
ew York	19,335	34,828	4,986	42,257	74,102	[d] 1,774,843
orth Carolina					416	[e] 12,266
orth Dakota						([f])
hio	32,716	40,555	4,970	38,800	3,235	1,244,752
klahoma	1,045		5,200	34,582	5	57,124
regon						([f])
ennsylvania	33,273	53,279	75,778	66,037	20,555	[d] 1,368,784
outh Dakota	4,883	6,000		2,500	2,000	128,554
ennessee						([g])
exas	58,230	27,000	7,038	850	9,550	154,948
tah			125		200	25,097
irginia						([g])
ashington	113,062			459		464,587
est Virginia	10,591	3,040	2,710	10,213	725	127,149
isconsin	50,521				86	219,130
yoming				2,010	200	44,574
Total	370,161	315,729	119,138	471,450	119,650	7,594,091

[a] Includes North Dakota and Oregon.
[b] Included with New Mexico.
[c] Includes Nevada.
[d] Includes bluestone.
[e] Includes Tennessee and Virginia.
[f] Included with Nebraska.
[g] Included with North Carolina.

Value of sandstone (including quartzite) production in the United States in 1908 and 1909, by States and Territories and uses—Continued.

1909.

State or Territory.	Rough building.	Dressed building.	Ganister.	Paving.	Curbing.	Flagging.	Rubble.
Alabama	$3,951	$23					$15,347
Arizona	46,126	70,200		$350		$398	126,500
Arkansas	5,638				$18,022	650	1,000
California	32,549	63,579		2,240	8,781		560
Colorado	56,678	42,222	$17,384	8,351	11,922	30,202	15,982
Connecticut							
Idaho	20,111	6,038					3,114
Illinois	2,047	2,420	4				624
Indiana	2,790				250	255	
Iowa	1,357	831					55
Kansas	11,748				144	6,443	1,019
Kentucky	33,863	55,579				1,320	
Maryland	3,508		6,786	290			
Massachusetts	222,620	60,470			40		26,000
Michigan	12,985	16,805					6,294
Minnesota	11,982	70,464		118,653	3,649		38,656
Missouri	6,245	11,350		262	191		5,357
Montana	9,237	52,209					494
Nevada							
New Jersey	110,987	39,090				1,208	178
New Mexico	4,963						
New York	147,401	301,240		235,961	347,824	291,439	26,104
North Dakota							
Ohio	372,680	403,641	600	500	366,038	391,340	5,320
Oklahoma	8,612						6,063
Oregon	506	155					150
Pennsylvania	336,113	234,274	169,218	56,088	178,117	231,858	45,374
South Dakota	26,118	12,121		45,870	900	40	9,165
Tennessee							
Texas	9,000	24,500		250			1,550
Utah	61,726	767		4,737		130	
Virginia	500	300					
Washington	43,139	81,830		126,648			1,075
West Virginia	38,925	61,448			1,889		22,295
Wisconsin	45,994	36,059	46,417				6,292
Wyoming	11,242	563					1,325
Total	1,701,341	1,648,178	240,409	600,200	937,767	955,283	365,893

Value of sandstone (including quartzite) production in the United States in 1908 and 1909, by States and Territories and uses—Continued.

1909—Continued.

State or Territory.	Riprap.	Crushed stone.			Other.	Total.
		Road making.	Railroad ballast.	Concrete.		
Alabama	$325			$51,432	$6,249	$77,327
Arizona	1,503		$2,055	51,203		298,335
Arkansas	6,910	$1,940	13,185	20,611		67,956
California	27,171	61,150	51,769	35,360	6,875	290,034
Colorado	50			13,784	530	197,105
Connecticut						(a)
Idaho						29,263
Illinois	22	21,774				26,891
Indiana	774				50	4,119
Iowa	100	100				2,443
Kansas					206	19,560
Kentucky	28	45				90,835
Maryland						10,584
Massachusetts	11,147	48,517		89,021	147	b 457,962
Michigan						36,084
Minnesota	1,042	44,017		10,235	660	299,358
Missouri	5,001				357	28,763
Montana	10,653				850	73,443
Nevada						(c)
New Jersey		32,435		5,100	100	189,098
New Mexico						4,963
New York	9,624	25,181	4,476	26,509	15,071	d 1,430,830
North Dakota						(e)
Ohio	11,623	31,168	9,100	25,410	21,586	1,639,006
Oklahoma				44,536	644	59,855
Oregon				4,000		f 4,811
Pennsylvania	66,261	69,872	146,818	90,469	13,332	d 1,637,794
South Dakota	8,121			15,094	600	g 118,029
Tennessee						(h)
Texas	4,700	10,800		10,800		61,600
Utah	200			25	3,650	71,235
Virginia		500	26,474	700	100	28,574
Washington	82,778					335,470
West Virginia	2,500	12,855	29,240	31,081	805	i 201,038
Wisconsin	26,107	33,477		10,613		204,959
Wyoming						13,130
Total	276,640	393,831	283,117	535,983	71,812	8,010,454

a Included in Massachusetts.
b Includes Connecticut.
c Included in Oregon.
d Includes bluestone.
e Included in South Dakota.
f Includes Nevada.
g Includes North Dakota.
h Included in West Virginia.
i Includes Tennessee.

Building stone.—Sandstone for building purposes, including rough and dressed stone, increased in value from $2,605,381 in 1908 to $3,349,519 in 1909, a gain of $744,138. Pennsylvania, New York, and Ohio produced the most building stone.

Ganister.—Ganister, reported from Pennsylvania, Wisconsin, Colorado, Maryland, Ohio, and Illinois, was valued at $240,409 in 1909, as against $175,325 in 1908, an increase of $65,084 in 1909.

Paving.—The total value of the paving stone decreased $54,696, from $654,896 in 1908 to $600,200 in 1909. New York, Washington, and Minnesota were large producers of this product.

Curbing.—Sandstone for curbing was valued at $1,025,259 in 1908; in 1909 the value was $937,767, a decrease of $87,492. Ohio, New York, and Pennsylvania were the principal producers of this material. The New York and Pennsylvania output was chiefly of bluestone.

Flagging.—Ohio, New York, and Pennsylvania were the chief States producing sandstone flagging, and although the Ohio and Pennsylvania output increased somewhat, the output from New York showed such a decided decrease that the total decrease amounted to $112,051, from $1,067,334 in 1908 to $955,283 in 1909.

Rubble.—Rubble decreased in value $303,875, from $669,768 in 1908 to $365,893 in 1909.

Riprap.—Sandstone sold for riprap decreased in value from $370,161 in 1908 to $276,640 in 1909, a loss of $93,521.

Crushed stone.—There was an increase in value in crushed sandstone of $306,614, from $906,317 in 1908 to $1,212,931 in 1909. The quantity increased from 1,199,872 short tons in 1908 to 1,717,785 in 1909, an increase of 517,913 tons. The average price per ton in 1908 was 76 cents; in 1909 it was 71 cents.

BLUESTONE.

The rock popularly known as "bluestone" in southern New York and northeastern Pennsylvania is a fine-grained, compact, dark blue-gray argillaceous sandstone. Logically its production should be included under sandstone in this report, but since the quarrying of this material in the locality mentioned forms a more or less distinct industry its value is given separately. Because of the peculiar method of quarrying bluestone, it has been found that the best figures of production are obtained from the dealers who buy the stone from the numerous small quarrymen, mostly farmers, who get out this stone at intervals. The dealers usually quarry for themselves also, and are better able to give the entire quantity of stone bought and sold than are the small producers. The principal channels to market for this stone are the Erie Railroad, the New York, Ontario and Western Railway, and Hudson River. The output of bluestone decreased in value from $1,762,860 in 1908 to $1,446,402 in 1909, or $316,458. The stone used for building purposes, flagging, curbing, and for miscellaneous purposes decreased in value, but that reported as disposed of as crushed stone showed a large increase.

The following table shows the value and uses of the bluestone produced in New York and Pennsylvania in 1908 and 1909:

Value and uses of bluestone produced in New York and Pennsylvania in 1908 and 1909.

1908.

State.	Building purposes.	Flagging.	Curbing.	Crushed stone.	Other purposes.	Total value.
New York	$415,652	$413,920	$313,319	$9,219	$68,852	$1,220,962
Pennsylvania	186,093	217,690	116,197	6,985	14,933	541,898
Total	601,745	631,610	429,516	16,204	83,785	1,762,860

1909.

State.	Building purposes.	Flagging.	Curbing.	Crushed stone.	Other purposes.	Total value.
New York	$378,960	[a] $264,770	[b] $241,253	$21,224	$11,389	$917,596
Pennsylvania	159,193	[c] 195,525	[d] 83,538	70,269	20,281	528,806
Total	538,153	460,295	324,791	91,493	31,670	1,446,402

[a] This value represents 4,129,324 square feet of stone.
[b] This value represents 1,968,329 linear feet of stone.
[c] This value represents 2,665,480 square feet of stone.
[d] This value represents 437,281 linear feet of stone.

LIMESTONE.

PRODUCTION.

Total value.—This report does not include the value of stone burned into lime and put on the market and sold as lime, except in cases where the stone is quarried by manufacturing plants and ultimately burned into lime and used in the manufacturing process. This applies especially to stone quarried by sugar factories and alkali works, which make no accounting for the lime, but measure the stone quarried. A large quantity of limestone used in the manufacture of Portland cement is also excluded from these figures; the value of this stone enters into and is included in the value of the cement.

The commercial output of lime is given separately in a succeeding chapter of this report.

The total value of limestone produced in 1909 was $32,070,401 as compared with $27,682,002 in 1908, an increase in 1909 of $4,388,399. This is the largest value recorded. The increase in value was largely in limestone used for fluxing purposes, although there was considerable increase in the value of rough building stone, riprap, crushed stone, and stone not classified. Decrease in value was reported for dressed building stone, paving blocks, curbing, flagging, rubble, and stone used in the manufacture of sugar.

The principal States that produced limestone in 1909 were, in order of rank of value, Pennsylvania, Illinois, Ohio, Indiana, New York, and Missouri, each reporting over $2,000,000. In each of these States, except Missouri, there was an increase.

The following table shows the value of limestone, by States, from 1905 to 1909, inclusive:

Value of limestone from 1905 to 1909, by States and Territories.

State or Territory.	1905.	1906.	1907.	1908.	1909.
Alabama	$532,103	$579,344	$694,699	$479,730	$700,642
Arizona	135	40	64,975	(a) 50,130	(b)
Arkansas	154,818	48,844	52,207	61,971	112,468
California	49,902	80,205	177,333	237,320	283,869
Colorado	289,920	373,158	502,751	378,822	355,136
Connecticut	1,558	1,171	1,476	(c) 3,727	(c) 5,023
Florida	5,800	1,450	15,000	41,910	(d) 49,856
Georgia	9,030	16,042	22,278	8,495	34,593
Hawaii	....	....	....	....	(e)
Idaho	14,105	12,600	15,900	36,000	(e)
Illinois	3,511,890	2,942,331	3,774,346	3,122,552	4,234,927
Indiana	3,189,259	3,725,565	3,624,126	3,643,261	3,749,239
Iowa	451,791	493,815	560,582	530,945	525,277
Kansas	923,389	849,203	813,748	403,176	892,335
Kentucky	744,465	795,408	891,500	810,190	903,874
Louisiana	....	....	....	....	(f)
Maine	7,428	2,000	1,350	(g)	(g)
Maryland	149,402	170,046	142,825	128,591	197,939
Massachusetts	65,908	10,750	1,837	1,950	....
Michigan	544,754	656,269	760,333	669,017	750,589
Minnesota	555,401	632,115	735,319	667,095	698,309
Missouri	2,238,164	1,988,334	2,153,917	2,130,136	2,111,283
Montana	103,123	141,082	124,690	134,595	154,064
Nebraska	225,119	276,381	312,630	330,570	293,830
New Jersey	147,353	221,141	274,452	172,000	224,017
New Mexico	7,200	125,493	193,732	(h)	(i) 140,801
New York	1,970,968	2,204,724	2,898,520	2,584,559	2,622,353
North Carolina	16,500	30,583	22,328	(j)	(j)
Ohio	2,850,793	3,025,038	3,566,822	3,519,557	4,020,046
Oklahoma	168,924	171,983	189,568	257,066	450,055
Oregon	8,600	7,480	5,750	6,230	....
Pennsylvania	4,499,503	4,865,130	5,821,275	4,057,471	5,073,825
Rhode Island	300	678	750	(g)	(g)
South Dakota	6,653	10,400	11,600	(k)	(l) 49,328
Tennessee	401,622	481,952	385,450	(m) 535,882	(m) 589,949
Texas	171,847	239,125	267,757	314,571	341,528
Utah	232,519	248,868	306,344	253,088	169,700
Vermont	11,095	14,728	23,126	20,731	18,839
Virginia	212,660	260,343	362,062	280,542	342,656
Washington	52,470	49,192	62,317	31,660	38,269
West Virginia	671,318	628,602	855,941	645,385	864,392
Wisconsin	804,081	891,746	1,027,095	1,102,009	1,047,044
Wyoming	23,340	53,783	18,920	(n) 31,168	24,346
Total	26,025,210	27,327,142	31,737,631	27,682,002	32,070,401

(a) Includes New Mexico.
(b) Included in New Mexico.
(c) Includes Maine and Rhode Island
(d) Includes Louisiana.
(e) Included in South Dakota.
(f) Included in Florida.
(g) Included with Connecticut.
(h) Included with Arizona.
(i) Includes Arizona.
(j) Included with Tennessee.
(k) Included with Wyoming.
(l) Includes Hawaii and Idaho.
(m) Includes North Carolina.
(n) Includes South Dakota.

The following table shows the value of limestone product in the United States in 1908 and 1909, by States and Territories and uses:

Value of the production of limestone in the United States in 1908 and 1909, by States and Territories and uses.

1908.

State or Territory.	Rough building.	Dressed building.	Paving.	Curbing.	Flagging.	Rubble.	Riprap.
Alabama	$912	$18,300				$1,620	$20,750
Arizona	1,800	4,500				700	
Arkansas	15,654	43,432				327	
California	614	90					
Colorado							
Connecticut							565
Florida	5,250	25,000				2,000	
Georgia	1,518		$1,020				
Idaho	4,200						
Illinois	49,193	21,253	2,576	$3,850	$3,227	366,490	152,582
Indiana	1,102,375	1,384,664	2,354	155,173	11,712	18,983	11,473
Iowa	63,277	24,858	4,146	3,355	4,661	84,554	48,405
Kansas	63,893	50,644	15,182	8,800	3,625	19,151	19,730
Kentucky	77,561	43,727	13,900	5,387	2,236	13,621	14,355
Maine							
Maryland	13,105		100		50	150	
Massachusetts	1,950						
Michigan	7,276		10,825	300	100	15,907	1,574
Minnesota	140,241	102,924	24,750	6,890	10,841	93,435	98,616
Missouri	254,286	349,311	4,380	4,421	6,758	138,448	107,243
Montana	12,126						
Nebraska	23,029	451		27		22,680	30,892
New Jersey	425						
New Mexico							
New York	123,973	128,415	27,473	7,974	2,295	34,766	39,982
North Carolina							
Ohio	70,884	12,460	8,824	1,055	605	488,492	61,823
Oklahoma	4,815	844		500	1,008	7,848	39,139
Oregon	100						
Pennsylvania	80,222	13,388	128,454	9,930	1,413	24,239	7,176
Rhode Island							
South Dakota							
Tennessee	7,884	3,680	1,315	3,213	190	12,579	21,233
Texas	23,662	2,280		480		4,375	44,088
Utah	32,358	3,200	519			5,951	25,000
Vermont	7,102		285	75	1,053		
Virginia	1,870	2,950		79	110		3,377
Washington							
West Virginia	10,800						
Wisconsin	97,172	24,784	30,534	26,070	29,197	46,444	104,119
Wyoming	5,840						
Total	2,305,367	2,261,155	276,637	237,579	79,081	1,402,760	852,122

Value of the production of limestone in the United States in 1908 and 1909, by States and Territories and uses—Continued.

1908—Continued.

State or Territory.	Crushed stone.			Flux.	Sugar factories.	Other.	Total.
	Road making.	Railroad ballast.	Concrete.				
Alabama	$43,028	$1,500	$6,651	$386,874		$95	$479,730
Arizona	350		350	42,430			[a] 50,130
Arkansas	2,373					185	61,971
California	25,185	2,700	12,000	86,945	$104,676	5,110	237,320
Colorado		2,000		276,140	100,172	510	378,822
Connecticut				1,488		1,674	[b] 3,727
Florida	9,660						41,910
Georgia	791	1,900	2,148	946		172	8,495
Idaho					31,800		36,000
Illinois	728,017	384,827	851,889	540,718	3,893	14,037	3,122,552
Indiana	622,726	95,165	77,011	139,703		21,922	3,643,261
Iowa	75,806	28,687	181,668		750	10,778	530,945
Kansas	29,800	99,306	74,555			18,490	403,176
Kentucky	350,577	235,802	35,482	11,283		6,159	810,090
Maine							(c)
Maryland	62,316	35,344	16,745	210		571	128,591
Massachusetts							1,950
Michigan	182,510	33,900	73,200	56,841	32,594	253,990	669,017
Minnesota	48,264	20,389	95,995	100	4,425	20,225	667,095
Missouri	726,772	130,296	341,768	14,678	5,970	45,805	2,130,136
Montana		756		116,071	5,642		134,595
Nebraska	51,007	16,010	173,449	11,700	1,250	75	330,570
New Jersey	18,294		2,533	149,301		1,447	172,000
New Mexico							(d)
New York	942,434	227,730	472,425	205,758	1,080	370,254	2,584,559
North Carolina							(e)
Ohio	1,436,874	349,535	246,516	635,354	2,500	204,635	3,519,557
Oklahoma	2,000	102,335	95,819			2,758	257,066
Oregon				130	6,000		6,230
Pennsylvania	653,503	300,702	419,518	2,324,173	20,034	74,719	4,057,471
Rhode Island							(c)
South Dakota							(f)
Tennessee	211,896	56,439	60,350	142,573		14,530	[g] 535,882
Texas	81,978	115,322	9,495	31,266		1,625	314,571
Utah	14		263	161,383	24,400		253,088
Vermont	9,275		2,535	334		72	20,731
Virginia	30,159	45,541	26,604	169,847		5	280,542
Washington				26,410		5,250	31,660
West Virginia	70,939	197,189	24,939	337,742		3,776	645,385
Wisconsin	464,345	47,363	192,248	25,935		13,798	1,102,009
Wyoming			420	8,908	16,000		[h] 31,168
Total	6,880,893	2,530,738	3,496,576	5,905,241	361,186	1,092,667	27,682,002

[a] Includes New Mexico.
[b] Includes Maine and Rhode Island.
[c] Included with Connecticut.
[d] Included with Arizona.
[e] Included with Tennessee.
[f] Included with Wyoming.
[g] Includes North Carolina.
[h] Includes South Dakota.

Value of the production of limestone in the United States in 1908 and 1909, by States and Territories and uses.

1909.

State or Territory.	Rough building.	Dressed building.	Paving.	Curbing.	Flagging.	Rubble.	Riprap.
Alabama	$775	$27,197	$2,000	$46,115		$8,460	$19,200
Arkansas	23,655	74,413				650	
California	12,341						
Connecticut							90
Florida	6,955					684	14,400
Georgia	954						
Illinois	62,395	34,323	2,600	4,348	$4,651	368,605	115,413
Indiana	1,235,524	1,353,180	534	109,454	4,921	14,100	7,939
Iowa	41,866	7,765		420		49,947	43,094
Kansas	75,574	43,775	22,044	160	493	58,519	41,984
Kentucky	130,784	63,844	4,583	16,313	219	6,596	20,081
Maryland	4,413		600	10			1,500
Michigan	4,450	7,445				1,572	3,615
Minnesota	169,929	96,809		5,697	5,031	94,453	42,666
Missouri	233,215	408,327	1,531	2,354	10,374	301,463	106,419
Montana	7,628						333
Nebraska	1,507	1,033				12,926	28,645
New Jersey	375					540	
New York	168,569	37,355	3,080	2,574	315	83,198	63,526
Ohio	102,109	31,133		624	180	27,675	430,789
Oklahoma	4,850	1,000				4,459	35,889
Pennsylvania	104,930	1,410	124,521	2,128	1,250	2,283	709
Tennessee	16,854	4,432		3,310		4,085	26,298
Texas	28,601	17,540	365	60		86,241	14,581
Utah	29,785						
Vermont	5,412						
Virginia	715	129	15		7	3,000	
Wisconsin	96,161	15,832	26,807	20,573	13,902	97,689	65,063
Wyoming						700	
Total	2,570,326	2,226,942	188,680	214,140	41,343	1,228,445	1,082,234

Value of the production of limestone in the United States in 1908 and 1909, by States and Territories and uses—Continued.

1909—Continued.

State or Territory.	Crushed stone.			Flux.	Sugar factories.	Other.	Total.
	Road making.	Railroad ballast.	Concrete.				
Alabama	$60,452	$5,521	$16,825	$512,585		$1,512	$700,642
Arizona							[a]
Arkansas	9,126	340	4,284				112,468
California	138,962		4,554	29,904	$92,233	5,875	283,869
Colorado	100			267,806	86,888	342	355,136
Connecticut				1,933		3,000	[b] 5,023
Florida	4,150	2,569	12,343			8,755	[c] 49,856
Georgia	749	14,091	3,103	15,696			34,593
Hawaii							[d]
Idaho							[d]
Illinois	1,216,759	422,859	1,249,783	714,631	1,971	36,589	4,234,927
Indiana	627,289	54,086	54,449	190,809	982	95,972	3,749,239
Iowa	116,246	16,329	246,054		675	2,881	525,277
Kansas	155,294	257,654	207,405	493		28,940	892,335
Kentucky	273,411	291,266	47,364	10,804		38,609	903,874
Louisiana							[e]
Maine							[f]
Maryland	108,630	20,071	61,201			1,514	197,939
Michigan	132,902	42,445	112,829	91,915	25,845	327,571	750,589
Minnesota	80,441	38,329	157,263		6,033	1,658	698,309
Missouri	542,904	87,445	339,036	31,075	13,321	33,819	2,111,283
Montana			15,400	127,532	3,171		154,064
Nebraska	83,147	31,898	118,523	15,000	1,136	15	293,830
New Jersey	8,321		8,346	206,435			224,017
New Mexico	3,750	107,500	3,150	15,395		11,006	[g] 140,801
New York	750,980	419,489	495,970	343,891		253,406	2,622,353
North Carolina							[h]
Ohio	1,502,483	332,569	236,619	1,130,082	2,088	223,695	4,020,046
Oklahoma	5,491	148,589	243,277			6,500	450,055
Pennsylvania	596,023	444,091	489,241	3,165,872		140,767	5,073,825
Rhode Island							[f]
South Dakota	7,184	12,600	5,400	1,200	22,944		[i] 49,328
Tennessee	276,945	95,665	72,706	87,432		2,222	[j] 589,949
Texas	125,661	3,400	24,260	40,819			341,528
Utah				126,915	13,000		169,700
Vermont	8,672		4,362	250		143	18,839
Virginia	31,076	84,883	8,068	213,444		1,319	342,656
Washington	225			31,317		6,727	38,269
West Virginia	47,152	294,938	19,865	492,497		9,940	864,392
Wisconsin	379,723	79,803	188,395	56,075		7,021	1,047,044
Wyoming					21,000	2,646	24,346
Total	7,294,248	3,308,430	4,450,075	7,921,807	291,287	1,252,444	32,070,401

[a] Included in New Mexico.
[b] Includes Maine and Rhode Island.
[c] Includes Louisiana.
[d] Included in South Dakota.
[e] Included in Florida.
[f] Included in Connecticut.
[g] Includes Arizona.
[h] Included in Tennessee.
[i] Includes Idaho and Hawaii.
[j] Includes North Carolina.

Building stone.—Limestone for building purposes, including rough and dressed stone sold by producers, increased in value $230,746—from $4,566,522 in 1908 to $4,797,268 in 1909. The increase was confined entirely to the rough stock, which increased in value from $2,305,367 in 1908 to $2,570,326 in 1909, while the dressed limestone decreased from $2,261,155 in 1908 to $2,226,942 in 1909.

The output of building stone in Indiana was valued at $2,588,704, which was not quite 54 per cent of the total for the United States, and therefore a little less than the proportion produced in 1908, which was 54.46 per cent. The gain in value for Indiana was $101,665. Most of the output of limestone in Indiana is quarried principally in Lawrence and Monroe counties, and is well known as Bedford oolitic limestone, from the town of Bedford, Lawrence County, which, with Bloomington, Monroe County, forms the shipping center for this stone. This Bedford stone is chiefly used for building stone, although some is sold for flagstone, curbstone, monumental stone, crushed stone, furnace flux, and some—not included in this report—is used for lime and for cement. Exclusive of 145,672 short tons of stone, valued at $71,637, used for riprap, crushed stone, furnace flux, etc., the total quantity and value of limestone produced in Lawrence County in 1909 was 6,441,483 cubic feet, valued at $1,678,195; Monroe County produced, exclusive of 106,600 short tons, valued at $56,925, for flux, etc., 2,970,388 cubic feet of other stone, valued at $801,436. The total for the two counties, exclusive of the flux, etc., was therefore 9,411,871 cubic feet, valued at $2,479,631. In 1908 the total output of building stone from these two counties was 8,347,093 cubic feet, valued at $2,379,040, a gain in 1909 of 1,064,778 cubic feet in quantity and of $100,591 in value. In 1908 the quantity of stone sold for other than building purposes from these two counties, not included in the above figures, was 101,705 short tons, valued at $43,869, an increase in 1909 in this class of material of 150,567 tons in quantity and of $84,693 in value. The low price per ton was due to the low price obtained for waste stone sold for flux. In 1908 the total quantity for the two counties included 5,373,992 cubic feet of stone sold rough, of which 3,442,440 cubic feet, valued at $767,763, were for Lawrence County, and 1,931,552 cubic feet, valued at $298,993, for Monroe County. In 1909 there were 6,603,992 cubic feet of rough stone sold, an increase for 1909 of 1,230,000 cubic feet for rough stock. In 1908 the two counties reported 2,983,101 cubic feet of dressed stone, of which 1,757,556 cubic feet, valued at $731,059, were from Lawrence County, and 1,225,545 cubic feet, valued at $581,225, from Monroe County. In 1909 the quantity of dressed stone sold was 2,807,879 cubic feet, a decrease of 175,222 cubic feet for 1909. In 1909 the total value of dressed stone for Lawrence County was $784,501 and for Monroe County $506,278—a gain in 1909 of $53,442 for Lawrence County and a decrease of $74,947 for Monroe County. Most of this stone was for building purposes, but there is included a small quantity for rubble, curbstone, and flagstone. The average price per cubic foot for rough stone in 1908 was 20 cents; in 1909 18 cents; for dressed stone in 1908 it was 44 cents and in 1909 46 cents.

The following table shows the production of Bedford oolitic limestone in Lawrence and Monroe counties, Ind., from 1901 to 1909, inclusive. This limestone was sold for rubble, riprap, curbing, flagging, and flux, and also as crushed stone for road making, ballast, concrete, etc.

Production of Bedford oolitic limestone in Lawrence and Monroe counties, Ind., 1901–1909.

Year.	Lawrence County.		Monroe County.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1901	....	$1,365,875	....	$421,599	....	$1,787,474
1902	....	1,207,497	....	439,902	....	1,637,399
1903	....	1,088,477	....	487,662	....	1,576,139
1904	....	1,054,302	....	589,672	....	1,643,974
1905	....	1,550,076	....	843,399	....	2,393,475
1906	....	1,460,743	....	1,162,062	[a]9,282,004	2,622,805
1907	....	1,413,280	....	908,612	[a]7,849,027	2,321,892
					[b]256,960	110,525
1908	[a]5,199,996	1,498,822	[a]3,147,097	880,218	[a]8,347,093	2,379,040
	[b]93,085	42,150	[b]8,260	1,719	[b]101,705	43,869
1909	[a]6,444,483	1,678,195	[a]2,970,388	801,436	[a]9,411,871	2,608,193
	[b]145,672	71,637	[b]106,600	56,925	[b]252,272	128,562

[a] Cubic feet. [b] Short tons.

The following table shows the production of Bedford oolitic limestone in Lawrence and Monroe counties, Ind., in 1908 and 1909, by uses:

Production of Bedford oolitic limestone in Lawrence and Monroe counties, Ind., in 1908 and 1909, by uses.

County.	Building.						Other uses.[a]		Total value.
	Rough.		Dressed.		Total.				
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
1908.									
	Cubic feet.		*Cubic feet.*		*Cubic feet.*		*Short tons.*		
Lawrence	3,442,440	$767,763	1,757,556	$731,059	5,199,996	$1,498,822	93,085	$42,150	$1,540,972
Monroe	1,931,552	298,993	1,225,545	581,225	3,147,097	880,218	8,620	1,719	881,937
Total	5,373,992	1,066,756	2,983,101	1,312,284	8,347,093	2,379,040	a 101,705	43,869	2,422,909
Average price		.20		.44		.29		.43	
1909.									
Lawrence	4,721,424	$893,694	1,720,059	$784,501	6,441,483	$1,678,195	145,672	$71,637	$1,749,832
Monroe	1,882,568	295,158	1,087,820	506,278	2,970,388	801,436	106,500	56,925	858,361
Total	6,603,992	1,188,852	2,807,879	1,290,779	9,411,871	2,479,631	a 252,272	128,562	2,608,193
Average price		.18		.46		.26		.51	

[a] Used for crushed stone, flux, curbing, flagging, etc.

Missouri ranked next to Indiana in output of building limestone, the value of the output being $641,542, as against $603,597 for 1908, a gain in 1909 of $37,945. This stone, a strong, light-gray crystalline limestone, is principally from Carthage, Jasper County. The value of the limestone produced in the Carthage district in 1909 was $370,002, as compared with $309,597 in 1908, an increase of $60,405. The output in 1909 consisted of 481,274 cubic feet of building stone valued at $334,715, an average of 69.5 cents per cubic foot; of curbing, valued at $1,263; of flagging, valued at $6,232; of rubble, valued at $3,791; and of stone for miscellaneous uses, valued at $24,001. All these items except curbing showed an increase in 1909.

The following table shows the production of limestone near Carthage, Jasper City, Mo., in 1908 and 1909, by uses:

Production of limestone at Carthage, Jasper County, Mo., in 1908 and 1909, by uses.

Year.	Number of producers.	Building stone.		Curbing.	Flagging.	Rubble.	Other.[a]	Total value.
		Quantity.	Value.	Value.	Value.	Value.	Value.	
		Cubic feet.						
1908	8	431,576	$280,249	$5,238	$3,602	$2,682	$17,826	$309,597
1909	8	481,274	334,715	1,263	6,232	3,791	24,001	370,002

[a] Includes stone used for monumental work, crushed stone, stone sold to glass factories, blast furnaces, sugar factories, etc.

Paving.—Limestone for paving decreased in value from $276,637 in 1908 to $188,680 in 1909, or $87,957. Pennsylvania, Wisconsin, and Kansas produced most of the limestone used for paving in 1909.

Curbing.—There was a decrease of $23,439 in the value of the curbstone output from $237,579 in 1908 to $214,140 in 1909. Indiana, Kentucky, and Wisconsin furnished most of this material in 1909.

Flagging.—A decrease of $37,748 marked the limestone output for flagging in 1909, from $79,081 in 1908 to $41,343 in 1909. Most of this stone was from Wisconsin and Missouri.

Rubble.—Rubble decreased in value $174,315, from $1,402,760 in 1908 to $1,228,445 in 1909. Illinois, Missouri, Wisconsin, and Minnesota reported the largest production.

Riprap.—Riprap increased in value $230,112, from $852,122 in 1908 to $1,082,234 in 1909. Ohio, Illinois, Missouri, and Wisconsin produced most of this stone in 1909.

Crushed stone.—Limestone for crushed stone used in road making, railroad ballast, concrete, etc., had a larger value than any other limestone product. In 1909 this output was 26,292,765 short tons, valued at $15,052,753, an increase of 3,379,271 short tons in quantity and of $2,144,546 in value for 1909 as compared with 1908, when the figures were 22,913,494 short tons, valued at $767,246.

In 1909 the total was divided into 11,413,794 short tons, valued at $7,294,248, for road making; 7,273,100 short tons, valued at $3,308,-430, for railroad ballast; and 7,605,871 short tons, valued at $4,450,-075, for concrete, which, compared with the itemized output for 1908—road making, 11,910,760 tons, valued at $6,880,893; railroad ballast, 5,095,109 tons, valued at $2,530,738; concrete, 5,907,625 tons, valued at $3,496,576—was a decrease of 496,966 tons in quantity and an increase of $413,355 in value for road making, an increase of 2,177,991 tons in quantity and of $777,692 in value for railroad ballast, and an increase of 1,698,246 tons in quantity and of $953,499 in value for concrete. It is possible that the stone for road making includes some stone used for concrete, some of the operators reporting that they were unable to subdivide, except approximately, their total output of crushed stone, not knowing the exact use which was to be made of the stone. The average price per short ton was 57 cents in 1909 compared with 56 cents in 1908.

Ohio ranked first in 1909 in the production of crushed limestone; Illinois ranked second.

Furnace flux.—Next to crushed stone, limestone sold for furnace flux shows the largest value. This product, on account of the shutting down of a large number of iron furnaces late in 1907, showed a large decrease in both quantity and value of output in 1908, the production in that year being 11,091,442 long tons, valued at $5,905,241; in 1909 the production was 15,772,863 long tons, valued at $7,921,807, an increase of 4,681,421 tons in quantity and of $2,016,566 in value. The average price per ton was 53 cents in 1908 and 1907, and 50 cents in 1909. Pennsylvania, Ohio, Illinois, Alabama, West Virginia, New York, and Colorado were the principal producers.

The following table shows the production of limestone for smelter, open hearth, and blast furnace flux in 1908 and 1909, by States, in long tons:

Production of furnace flux, etc., in 1908 and 1909, by States, in long tons.

State or Territory.	1908.		1909.	
	Quantity.	Value.	Quantity.	Value.
Alabama	582,958	$386,874	974,650	$512,585
Arizona	70,718	42,430	(a)	(a)
California	78,305	86,945	13,769	29,904
Colorado	441,490	276,140	462,291	267,806
Connecticut	2,564	b 1,488	(a)	(a)
Georgia	1,522	946	18,850	15,696
Illinois	1,209,326	540,718	1,820,590	714,631
Indiana	272,505	139,703	369,938	190,809
Kansas			528	493
Kentucky	21,947	11,283	18,919	10,804
Maryland	421	210		
Michigan	104,186	56,841	197,061	91,915
Minnesota	100	100		
Missouri	18,524	14,678	43,909	31,075
Montana	216,964	116,071	232,535	127,532
Nebraska	18,000	11,700	10,000	15,000
New Jersey	318,455	149,301	402,333	206,435
New York	357,194	205,758	580,802	343,891
North Carolina			(c)	(c)
Ohio	1,444,412	635,354	2,161,681	1,130,082
Oregon	104	130		
Pennsylvania	4,350,381	2,324,173	6,593,822	3,165,872
Rhode Island		(d)	(a)	(a)
Tennessee	260,294	142,573	157,789	e 87,432
Texas	43,716	31,266	67,821	40,819
Utah	209,708	161,383	177,107	126,915
Vermont	334	334	249	250
Virginia	289,369	169,847	388,746	213,444
Washington	43,640	26,410	30,906	31,317
West Virginia	666,087	337,742	900,993	492,497
Wisconsin	62,718	25,935	110,212	56,075
Wyoming	5,500	8,908		
Other States			37,362	f 18,528
Total	11,091,442	5,905,241	15,772,863	7,921,807
Average price per ton		.53		.50

a Included in other States.
b Includes Rhode Island.
c Included in Tennessee.
d Included with Connecticut.
e Includes North Carolina.
f Includes Arizona, Connecticut, and Rhode Island.

Other purposes.—Stone reported as sold to sugar refiners decreased in value from $361,186 in 1908 to $291,287 in 1909, a loss of $69,899. Stone for other purposes includes stone quarried and used by alkali works in New York and Michigan, stone sold to glass factories, to paper mills, to carbonic-acid plants, for making whiting and mineral wool, and also a small quantity sold to farmers for burning into lime to be used as a fertilizer, it being impossible to get the lime value for this stone. This output increased in value $159,777—from $1,092,667 in 1908 to $1,252,444 in 1909.

MARBLE.

Total value.—The figures for marble production here presented include, for some of the States, the value of quantities of serpentine (verde antique marble) and "onyx" marble. The serpentine (verde antique marble) included is that form of serpentine which, from its use as ornamental stone for interior decorative work in buildings, answers the purpose of marble. The Georgia and Pennsylvania figures in this report include this stone. Onyx marble, or cave onyx, is included in the production of Kentucky and New Mexico in this report.

In 1909 the commercial output of marble was from Vermont, Georgia, Tennessee, Colorado, New York, Massachusetts, Pennsylvania, Alabama, California, Alaska, Maryland, North Carolina, Kentucky, Washington, Oregon, New Mexico, Arizona, Utah, and West Virginia, named in order of value of output. The most noteworthy change in the rank of States was that of Colorado, which rose from tenth to fourth place, on account of the large output from the Yule Creek quarries and the finishing mills at Marble, Gunnison County.

The marble output in the United States was valued in 1908 at $7,733,920; in 1909 it was valued at $6,548,905, a loss of $1,185,015.

The chief uses of marble are as building stone, for exterior and interior work, and for monuments.

The following table shows the value of the marble produced in the United States from 1905 to 1908, inclusive, by States and Territories:

Value of marble produced in the United States, 1905–1909, by States and Territories.

State or Territory.	1905.	1906.	1907.	1908.	1909.
Alabama		$85,000	$85,475	[a] $118,580	[b] $212,462
Alaska	$710	(c)	38,110	[d] 103,888	[e] 46,900
Arizona					(f)
Arkansas	1,000	16,900			
California	95,540	103,048	183,285	60,408	89,392
Colorado				(g)	[h] 488,311
Georgia	774,550	919,356	864,757	916,281	766,449
Idaho			(i)		
Kentucky			12,500	(j)	(j)
Maryland	138,404	176,495	98,918	[k] 79,317	(j)
Massachusetts	166,360	271,934	212,438	175,648	243,711
Missouri		(l)	(l)	(j)	
Nevada		5,000			
New Mexico	2,200	500	[m] 7,535	(g)	[n] 5,390
New York	795,721	557,954	911,951	706,858	402,729
North Carolina				(o)	(j)
Oklahoma			16,805		
Oregon					(p)
Pennsylvania	97,887	171,632	118,539	102,747	186,037
Tennessee	582,229	635,821	688,148	790,233	613,741
Texas					(f)
Utah	1,150	1,400	2,500	(g)	(p)
Vermont	4,410,820	4,576,913	4,596,724	4,679,960	3,493,783
Washington	60,000	59,985	(i)		(g)
West Virginia					(j)
Wyoming	2,500	1,000			
Total	7,129,071	7,582,938	7,837,685	7,733,920	6,548,905

a Includes Kentucky and Missouri.
b Includes Kentucky, Maryland, North Carolina, and West Virginia.
c Included in Washington.
d Includes Colorado, New Mexico, and Utah.
e Includes Washington.
f Included in New Mexico.
g Included in Alaska.
h Includes Oregon and Utah.
i Included in New Mexico.
j Included in Alabama.
k Includes North Carolina.
l Included in limestone.
m Includes Idaho and Washington.
n Includes Arizona and Texas.
o Included in Maryland.
p Included in Colorado.

Value of the marble product, 1908 and 1909, by States and Territories and uses.

1908.

State or Territory.	Rough.			Dressed.					Total.
	Building.	Monumental.	Other purposes.	Building.	Monumental.	Ornamental.	Interior decoration.	Other uses.	
Alabama	$898	....	$2,500	$113	$4,650	....	$77,000	$33,419	a $118,580
Alaska	38,500	$1,688	....	45,000	7,200	$500	10,600	400	b 103,888
California	8,100	1,250	....	....	....	....	50,782	276	60,408
Colorado	....	....	....	....	....	....	....	....	(c)
Georgia	368,981	342,000	78,800	100,000	17,500	....	....	9,000	916,281
Kentucky	....	....	....	....	....	....	....	....	(d)
Maryland	1,050	8,425	4,652	65,190	....	....	....	....	e 79,317
Massachusetts	1,888	....	....	110,856	19,786	....	34,660	8,458	175,648
Missouri	....	....	....	....	....	....	....	....	(d)
New Mexico	....	....	....	....	....	....	....	....	(c)
New York	74,538	56,200	30,421	472,407	53,292	....	20,000	....	706,858
North Carolina	....	....	....	....	....	....	....	....	(f)
Pennsylvania	13,444	....	....	54,803	9,000	7,000	15,000	3,500	102,747
Tennessee	83,764	10,755	37,575	78,440	17,590	....	551,449	10,660	790,233
Utah	....	....	....	....	....	....	....	....	(c)
Vermont	156,325	134,036	190	1,402,629	1,714,408	18,006	1,184,259	70,107	4,679,960
Total	747,488	554,354	154,138	2,329,438	1,843,426	25,506	1,943,750	135,820	7,733,920

a Includes Kentucky and Missouri.
b Includes Colorado, New Mexico, and Utah.
c Included in Alaska.
d Included in Alabama.
e Includes North Carolina.
f Included in Maryland.

1909.

State or Territory.	Rough.			Dressed.					Total
	Building.	Monumental.	Other uses.	Building.	Monumental.	Ornamental.	Interior decoration.	Other uses.	
Alabama	$39,825	$22,783	$6,900	$12,000	....	....	$129,554	$1,400	a $212,462
Alaska	42,100	300	500	....	$4,000	....	....	....	b 46,900
Arizona	....	....	....	....	....	....	....	....	(c)
California	83,887	563	4,942	....	....	....	....	....	89,392
Colorado	190,600	175	....	....	2,045	....	295,491	....	d 488,311
Georgia	528,454	25,000	15,745	156,000	26,250	....	....	15,000	766,449
Kentucky	....	....	....	....	....	....	....	....	(e)
Maryland	....	....	....	....	....	....	....	....	(e)
Massachusetts	23,759	900	1,424	16,500	53,372	$695	134,561	12,500	243,711
New Mexico	500	2,950	940	1,000	....	....	....	....	f 5,390
New York	64,400	49,950	32,641	135,919	88,559	....	31,260	....	402,729
North Carolina	....	....	....	....	....	....	....	....	(e)
Oregon	....	....	....	....	....	....	....	....	(g)
Pennsylvania	29,108	1,700	5,751	107,978	7,500	....	34,000	....	186,037
Tennessee	130,315	4,625	35,575	36,478	4,275	....	394,973	7,500	613,741
Texas	....	....	....	....	....	....	....	....	(c)
Utah	....	....	....	....	....	....	....	....	(g)
Vermont	455,300	462,580	66,144	827,144	998,671	24,000	537,944	122,000	3,493,783
Washington	....	....	....	....	....	....	....	....	(h)
West Virginia	....	....	....	....	....	....	....	....	(e)
Total	1,588,248	571,526	170,562	1,293,019	1,184,672	24,695	1,557,783	158,400	6,548,905

a Includes Kentucky, Maryland, North Carolina, and West Virginia.
b Includes Washington.
c Included in New Mexico.
d Includes Oregon and Utah.
e Included in Alabama.
f Includes Arizona and Texas.
g Included in Colorado.
h Included in Alaska.

The following table shows the various uses to which the marble quarried in 1904, 1905, 1906, 1907, 1908, and 1909 was put:

Distribution and value of output of marble, 1904–1909, among various uses.

Use.	1904.	1905.	1906.	1907.	1908.	1909.
Sold by producers in rough state	$2,599,052	$2,987,542	$1,795,169	$1,697,891	$1,455,980	$2,330,336
Dressed for building	988,671	1,168,450	1,559,925	1,905,145	2,329,438	1,293,019
Ornamental purposes	21,554	13,643	44,523	25,050	25,506	24,695
Dressed for monumental work	1,211,389	1,170,279	2,214,872	2,044,000	1,843,426	1,184,672
Interior decoration in buildings	1,257,963	1 682,651	1,722,445	1,900,952	1,943,750	1,557,783
Other uses	219,206	106,506	246,004	264,647	135,820	158,400
Total	6,297,835	7,129,071	7,582,938	7,837,685	7,733,920	6,548,505

Building stone.—The value of building marble, rough and dressed, as sold by the producer, was $2,881,267 in 1909, a decrease of $195,659 from the value for 1908, which was $3,076,926. The total for 1909 includes $1,588,248 for rough and $1,293,019 for dressed building stone; in 1908, the rough building marble sold was valued at $747,488 and the dressed building stone at $2,329,438, an increase in 1909 of $840,760 for rough stock and a decrease of $1,036,419 for dressed marble.

Vermont produces most of the building marble, the value of whose output in 1909 was $1,282,444, or 44.5 per cent of the total. This was chiefly dressed stone. The percentage for Vermont in 1908 was 50.67 and the value was $1,558,954.

The Georgia output, which is principally rough stone, was valued at $684,454 and represented 23.7 per cent of the total.

Monumental stone.—Monumental marble was valued at $2,397,780 in 1908 and at $1,756,198 in 1909, a decrease of $641,582 for 1909. In 1908 the value of rough stock was $554,354, and of dressed monumental stone, $1,843,426; the corresponding figures for 1909 were $571,526 for rough monumental stock and $1,184,672 for dressed monumental stone, an increase in 1909 of $17,172 in value of rough stock and a decrease of $658,754 for dressed stone. Vermont, with an output valued at $1,461,251, produced 83.2 per cent of the total monumental marble; New York, with 3.8 per cent, ranked second; and Georgia, producing about 3 per cent, ranked third. The Vermont stone was chiefly dressed stone; the New York and Georgia material was almost evenly divided between rough stone and dressed stone.

Interior work.—Vermont, Tennessee, Colorado, Massachusetts, and Alabama produced most of the marble used for interior decoration, the total value for 1909 being $1,557,783, as against $1,943,750 for 1908, a loss in 1909 of $385,967. The Vermont output represents 34.5 per cent, the Tennessee output 25.3 per cent, and the Colorado output 18.9 per cent of the total marble produced for interior work.

Other marble.—Rough stone for other purposes includes waste marble sold to lime burners, to carbonic acid factories, to pulp mills, to iron furnaces for flux, and used for road making, etc., and dressed stone includes stone for mosaics, electrical work, etc.

The output of marble for unclassified uses in 1909 was valued at $158,400, as compared with $135,820 in 1908, an increase of $22,580.

SURVEY PUBLICATIONS ON BUILDING STONE, SLATE, AND ROAD METAL.

The following list comprises the more important publications on stone, slate, and road metal by the United States Geological Survey. These publications, except those to which a price is affixed, can be obtained free by applying to the Director, United States Geological Survey, Washington, D. C. The priced publications may be purchased from the Superintendent of Documents, Government Printing Office, Washington, D. C. The annual volumes on Mineral Resources of the United States contain not only statistics of stone production but occasional discussions of available stone resources in various parts of the country. Many of the Survey's geologic folios also contain notes on stone resources that may be of local importance.

Alden, W. C. The stone industry in the vicinity of Chicago, Ill. Bull. 213, pp. 357–360. 1903. 25c.

Bain, H. F. Notes on Iowa building stones. Sixteenth Ann. Rept., pt. 4, pp. 500–503. 1895. $1.20.

Bastin, E. S. (See Leighton, Henry, and Bastin, E. S.)

Burchard, E. F. Concrete materials produced in the Chicago district. Bull. 340, pp. 383–410. 1908.

——— Structural materials near Austin, Tex. Bull. 430, pp. 292–316. 1910.

——— Structural materials near Minneapolis, Minn. Bull. 430, pp. 280–291. 1910.

Clapp, F. G. Limestones of southwestern Pennsylvania. Bull. 249. 1905.

Coons, A. T. Stone. Mineral resources U. S. for 1908, pt. 2, pp. 533–579. 1909.

Dale, T. N. The slate belt of eastern New York and western Vermont. Ninteenth Ann. Rept., pt. 3, pp. 153–200. 1899. $2.25.

——— The slate industry of Slatington, Pa., and Martinsburg, W. Va. Bull. 213, pp. 361–364. 1903. 25c.

——— Notes on Arkansas roofing slates. Bull. 225, pp. 414–416. 1904. 35c.

——— Slate investigations during 1904. Bull. 260, pp. 486–488. 1905. 40c.

——— Note on a new variety of Maine slate. Bull. 285, pp. 449–450. 1906. 60c.

——— Recent work on New England granites. Bull. 315, pp. 356–359. 1907.

——— The granites of Maine. Bull. 313. 202 pp. 1907.

——— The chief commercial granites of Massachusetts, New Hampshire, and Rhode Island. Bull. 354. 228 pp. 1908.

——— The granites of Vermont. Bull. 404. 138 pp. 1909.

——— Supplementary notes on the granites of New Hampshire. Bull. 430, pp. 346–372. 1910.

Dale, T. N., and others. Slate deposits and slate industry of the United States. Bull. 275. 154 pp. 1906. 15c.

Darton, N. H. Marble of White Pine County, Nev., near Gandy, Utah. Bull. 340, pp. 377–380. 1908.

——— Structural materials near Portland, Oreg., and Seattle and Tacoma, Wash. Bull. 387. 36 pp. 1909.

Diller, J. S. Limestone of the Redding district, California. Bull. 213, p. 365. 1903. 25c.

Eckel, E. C. Slate deposits of California and Utah. Bull. 225, pp. 417–422. 1904. 35c.

Gardner, James H. Oolitic limestone at Bowling Green and other places in Kentucky. Bull. 430, pp. 373–378. 1910.

Hillebrand, W. F. Chemical notes on the composition of the roofing slates of eastern New York and western Vermont. Nineteenth Ann. Rept., pt. 3, pp. 301–305. 1899. $2.25.

Hopkins, T. C. The sandstones of western Indiana. Seventeenth Ann. Rept., pt. 3 (continued), pp. 780–787. 1896. $1.00.

——— Brownstones of Pennsylvania. Eighteenth Ann. Rept., pt. 5 (continued), pp. 1025–1043. 1897. $1.00.

Hopkins, T. C., and Siebenthal, C. E. The Bedford oolitic limestone of Indiana. Eighteenth Ann. Rept., pt. 5 (continued), pp. 1050–1057. 1897. $1.00.

Humphrey, R. L. The fire-resistive properties of various building materials. Bull. 370. 99 pp. 1909. 20c.

Keith, A. Tennessee marbles. Bull. 213, pp. 366–370. 1903. 25c.

Leighton, Henry, and Bastin, E. S. Road materials of southern and eastern Maine. Bull. 33, Office of Public Roads, Department of Agriculture. 1908. (May be obtained from Department of Agriculture.)

Purdue, A. H. The slates of Arkansas. Bull. 430, pp. 317–334. 1910.

Ries, H. The limestone quarries of eastern New York, western Vermont, Massachusetts, and Connecticut. Seventeenth Ann. Rept., pt. 3 (continued), pp. 795–811. 1896. $1.00.

Shaler, N. S. Preliminary report on the geology of the common roads of the United States. Fifteenth Ann. Rept., pp. 259–306. 1895. $1.70.

——— The geology of the road-building stones of Massachusetts, with some consideration of similar materials from other parts of the United States. Sixteenth Ann. Rept., pt. 2, pp. 277–341. 1895. $1.25.

Siebenthal, C. E. The Bedford oolitic limestone [Indiana]. Nineteenth Ann. Rept., pt. 6 (continued), pp. 292–296. 1898. $1.00.

——— (See also Hopkins, T. C., and Siebenthal, C. E.)

Smith, G. O. The granite industry of the Penobscot Bay district, Maine. Bull. 260, pp. 489–492. 40c.

Udden, Jon A. Oolitic limestone industry at Bedford and Bloomington, Ind. Bull. 430, pp. 335–345. 1910.

Watson, T. L. Granites of the southeastern Atlantic States. Bull. 426. 282 pp. 1910.

STONE AND SLATE STATISTICS.

The statistical reports on the production of stone, etc., will be found in the following volumes of Mineral Resources of the United States:

1882. Structural materials, pp. 450–464, 50c.
1883–4. Structural materials, pp. 662–670, 60c.
1885. Structural materials, by H. H. Sproull, pp. 396–413, 60c.
1886. Structural materials, by Wm. C. Day, pp. 517–566, 40c.
1887. Structural materials, by Wm. C. Day, pp. 503–534, 50c.
1888. Structural materials, by Wm. C. Day, pp. 516–557, 50c.
1889–90. Stone, by Wm. C. Day, pp. 373–440, 50c.
1891. Stone, by Wm. C. Day, pp. 456–473, 50c.
1892. Stone, by Wm. C. Day, pp. 704–711, 50c.
1893. Stone, by Wm. C. Day, pp. 543–602, 50c.
1894. Sixteenth Ann. Rept., U. S. Geol. Survey, pt. 4, Nonmetallic products.
Stone, by Wm. C. Day, pp. 436–510.
1895. Seventeenth Ann. Rept., U. S. Geol. Survey, pt. 3 (continued), Nonmetallic products, except coal.
Stone, by Wm. C. Day, pp. 759–811.
1896. Eighteenth Ann. Rept., U. S. Geol. Survey, pt. 5 (continued), Nonmetallic products, except coal.
Stone, by Wm. C. Day, pp. 948–1068.
1897. Nineteenth Ann. Rept., U. S. Geol. Survey, pt. 6 (continued), Nonmetallic products, except coal and coke.
Stone, by Wm. C. Day, pp. 205–309.
1898. Twentieth Ann. Rept., U. S. Geol. Survey, pt. 6 (continued), Nonmetallic products, except coal and coke.
Stone, by Wm. C. Day, pp. 269–464.
1899. Twenty-first Ann. Rept., U. S. Geol. Survey, pt. 6 (continued), Nonmetallic products, except coal and coke.
Stone, pp. 333–360.

1900. Stone, pp. 661–691, 70c.
1901. Stone, pp. 641–666, 70c.
1902. Stone, pp. 665–701.
1903. Stone, pp. 755–789, 70c.
1904. Stone, pp. 801–841.
1905. Slate, by A. T. Coons, pp. 1011–1017; Stone, by A. T. Coons, pp. 1021–1067, $1.00.
1906. Slate, by A. T. Coons, pp. 1001–1005; Stone, by A. T. Coons, pp. 1007–1041.
1907. Slate, by A. T. Coons, pt. 2, pp. 557–562; Stone, by A. T. Coons, pt. 2. pp. 563–605, 50c.
1908. Slate, by A. T. Coons, with general note on the classification and characteristics of slate, by T. Nelson Dale, pt. 2, pp. 521–532; Stone, by A. T. Coons, pt. 2, pp. 533–579, 80c.
1909. Slate, by A. T. Coons; Stone, by E. F. Burchard, pt. 2.

ABRASIVE MATERIALS.

By W. C. Phalen.

INTRODUCTION.

The abrasive industry comprises the manufacture of many abrasive products. This article includes only the statistics of production of the raw material that enters into these products or, at most, such raw material as has been passed through only the very early stages of preparation for the market. Notes are given on the following materials: (1) Millstones and burrstones, (2) grindstones and pulpstones, (3) oilstones and scythestones, (4) corundum and emery, (5) abrasive garnet, (6) infusorial earth and tripoli, (7) pumice, and (8) the artificial abrasives carborundum, alundum, and crushed steel. Corubin, an artificial abrasive recently placed on the American market, is manufactured abroad. Aloxite and samite are trade names applied to forms of corundum recently placed on the American market.[a]

This report gives the statistics of only that part of the production of the natural abrasives that properly enters into the abrasive industry. Thus, only a small percentage of the sandstone that is quarried is used in the manufacture of abrasives—grindstones and pulpstones—the remainder being used chiefly in the building industry. Again, there is difficulty in separating that portion of the production of tripoli and infusorial earth which is used for strictly abrasive purposes from that which is not, and it is probable that in future reports these commodities will be described in another chapter of this volume. A large part of both of these products is not used as an abrasive, but is applied to other and diverse uses. Infusorial earth, for example, which is a nonconductor of heat and is of light weight, is therefore used extensively as a packing material for furnaces, steam pipes, and boilers, and as a fireproof building material. A more complete description of this material and its other uses is given further on in this report. Similarly, tripoli, in addition to being ground and used as an abrasive, is used as a filtering medium. A full account of the tripoli industry in southwestern Missouri is given on a subsequent page. The statistics of production of abrasive quartz and feldspar are not included in this report for the reason that, in the returns received by the Survey, it has been impracticable to segregate the portion of this material used as an abrasive. The entire output of

[a] Industrial World, November 28, 1910.

millstones, pumice, emery, and garnet (except gem garnet) is used in the abrasive industry.

Detailed descriptions of the occurrence and mode of preparation of the different abrasive materials have appeared in preceding reports of the United States Geological Survey. Thus, in the report for 1901, millstones, oilstones, whetstones, grindstones, burrstones, and infusorial earth and tripoli were described at considerable length by Joseph Hyde Pratt. In the report for 1903 an article on carborundum by F. A. J. Fitzgerald[a] was quoted, and also an abstract of a paper on crushed steel by M. M. Kann.[b] In the report for 1907 a detailed description was given of the method of preparing millstones from the Shawangunk conglomerate, in Ulster County, N. Y.—the center of the millstone industry in that State—and of the method of preparing Missouri tripoli for use in filters. In the same report the garnet deposits in New York were treated at considerable length, as well as the occurrence of pumice in the central Western States, and a detailed description of the manufacture and technology of alundum, an artificial abrasive, was also given. In the report for 1908 a detailed account was given of the scythestone industry in New Hampshire. Some of the statements and quotations regarding various abrasive industries that appeared in 1907 and 1908 are incorporated in the present report, as the natural abrasive industries do not change rapidly and the descriptions still hold good. A brief description of the millstone industry in Virginia and a recent report by Gaylord Nelson[c] on the tripoli industry of Missouri are also given in this chapter.

In 1909 there was a notable advance in the production and value of the natural abrasives, particularly of grindstones and pulpstones, infusorial earth and tripoli, garnet, and emery, though the emery industry is still very small. The advance in the millstone industry was not marked, and there was an actual falling off in the oilstone and scythestone and the pumice industries. Though the natural abrasive business as a whole showed a marked improvement, it is smaller than it was before the depression of 1908.

The following table gives the value of all the natural abrasive materials produced in the United States from 1905 to 1909, inclusive:

Value of natural abrasives produced in the United States, 1905–1909.

Kind of abrasive.	1905.	1906.	1907.	1908.	1909.
Oilstones and scythestones	$244,546	$268,070	$264,188	$217,284	$214,019
Grindstones and pulpstones	777,606	744,894	896,022	536,095	804,051
Burrstones and millstones[d]	37,974	48,590	31,741	31,420	35,393
Pumice	5,540	16,750	33,818	39,287	33,439
Infusorial earth and tripoli	64,637	72,108	104,406	97,442	122,348
Abrasive quartz and feldspar	88,118	121,671	126,582	79,146	([e])
Garnet	148,095	157,000	211,686	64,620	102,315
Corundum and emery	61,464	44,310	12,294	8,745	18,185
Total	1,427,980	1,473,393	1,680,737	1,074,039	1,329,750

[a] Iron Age, October 15, 1903.
[b] Proc. Am. Assoc. Adv. Sci., Pittsburg meeting, 1903.
[c] Mining World, September 11, 1909, p. 552.
[d] The figures represent the value of millstones only.
[e] See chapter on Quartz and feldspar.

Natural abrasives were produced in 21 States in 1909. A list of the producing States, with the material produced by each, is given below:

ALABAMA: Millstones.
ARKANSAS: Oilstones.
CALIFORNIA: Infusorial earth.
COLORADO: Grindstones.
CONNECTICUT: Infusorial earth.
GEORGIA: Infusorial earth.
IDAHO: Pumice.
ILLINOIS: Tripoli.
INDIANA: Oilstones.
MASSACHUSETTS: Emery and infusorial earth.
MICHIGAN: Grindstones and scythestones.
MISSOURI: Tripoli.
NEBRASKA: Pumice.
NEW HAMPSHIRE: Scythestones.
NEW YORK: Millstones, emery, garnet, and infusorial earth.
NORTH CAROLINA: Millstones and garnet.
OHIO: Grindstones, pulpstones, oilstones, and scythestones.
PENNSYLVANIA: Millstones.
VERMONT: Scythestones.
VIRGINIA: Millstones.
WEST VIRGINIA: Grindstones.

Under the head of artificial abrasives are included carborundum, alundum, and crushed steel. In comparing the production of artificial abrasives in 1909 with that of past years, it will be well to look back beyond the year 1908, which was a year of general business depression, and to compare the industry in 1909 with what it was in 1907, which may be regarded as a normal year. The production of 1909 showed an increase of 5,836,000 pounds in quantity and of $338,574 in value, as compared with that of 1907, the percentage of increase being, respectively, 39.9 and 33. The artificial abrasive industry is apparently advancing steadily. The production of artificial abrasives from 1906 to 1909 is as follows:

Production and value of artificial abrasives in the United States, 1906–1909.

Year.	Quantity, in pounds.	Value.	Year.	Quantity, in pounds.	Value.
1906	11,774,300	$777,081	1908	8,698,000	$626,340
1907	14,632,000	1,027,246	1909	20,468,000	1,365,820

The total estimated value of all abrasive materials consumed in the United States for the years 1905 to 1909, inclusive, is given in the following table:

Total value of all abrasive materials consumed in the United States, 1905–1909.

Year.	Natural abrasives.	Artificial abrasives.	Imports.	Total value.
1905	$1,427,980	$701,400	$654,821	$2,784,001
1906	1,473,393	777,081	909,964	3,160,438
1907	1,680,737	1,027,246	754,140	3,462,123
1908	1,074,039	626,340	476,073	2,176,452
1909	1,329,750	1,365,820	653,779	3,349,349

BURRSTONES AND MILLSTONES.

PRODUCTION.

The production of burrstones and millstones in the United States in 1909 was valued at $35,393, a slight increase over the value reported for 1908, which was $31,420.

The output came from New York, Virginia, North Carolina, Pennsylvania, and Alabama. Virginia did not produce as much as New York, but the increase in production in Virginia has been more marked and that State now stands a close second in the millstone industry.

The market for millstones has been greatly curtailed in recent years, because of the introduction of superior forms of grinding machinery, such as rolls and ball mills. The roller-mill process is now used almost exclusively in grinding wheat. Some corn and mustard mills in the Southern States still use handmade millstones. A part of the millstone product is sold to manufacturers of cement and talc and grinders of quartz and mineral paints.

MILLSTONE INDUSTRY IN NEW YORK.

New York has led for many years in the production of millstones and chasers, the latter term being applied to stones which run on edge. The raw material is obtained in Ulster County, southeastern New York, and is known as Esopus stone, Esopus being an early name for Kingston, which was formerly the main point of shipment. The material suitable for millstones is quarried from the Shawangunk conglomerate, which is found near the western base of Shawangunk Mountain, in the valley of Rondout River. The material suitable for millstones is exceedingly scanty, being confined in linear extent to a strip extending from High Falls on the north to Kerhonkson on the south, a distance of approximately 10 miles. Beyond these limits the texture and other properties of the rock have been found unsuitable for the highest grade of stones.

The methods employed in quarrying the rock are simple. The rock is pried or split out, advantage being taken of the joint planes, especially the concentric surface joints. The tools used are the ordinary hand drill, together with plugs and feathers. Blasting is often resorted to, but the charges of powder are usually light. The rough stones thus obtained are quarry dressed and finished, these operations being performed entirely by hand, the chief tools employed being the bull point and hammer. The operation of drilling the "eye" is performed by centering the stone and then drilling from the center of both faces inward. In many stones the eye is square. To fashion a square eye, a round eye is first drilled out and then squared up. A few of the men engaged in the industry make a modification of the regular millstone for use in the grinding of paint. In this modification the ordinary millstone is cut in halves and an iron casting is placed between the halves, which are then joined together by an iron band.

Chasers are larger than the regular millstones. They are used for heavier work, such as grinding quartz, feldspar, barytes, etc., and, as already mentioned, they run on edge. Though they are made with a diameter as short as 24 inches, they are usually turned out with diameters ranging from 50 to 84 inches, and as much as 22 inches in thickness. These chasers are run on pans paved with blocks of the conglomerate, which as a rule are roughly cubical, with edges about a foot in length. In grinding quartz in such pans the chasers are used in the preliminary crushing; then rough blocks, usually three in number, are either attached to or carried along by lateral arms, which in turn are joined to a vertical revolving shaft. By the circular movement of these blocks the material placed in the pan is ground to powder.

MILLSTONE INDUSTRY IN VIRGINIA.

The millstone industry in Virginia is confined to quarries near Price's Fork, Montgomery County, about 5 miles west of Blacksburg, the site of the Virginia Polytechnic Institute. The rock is regarded as of Mississippian (lower Carboniferous) age. The material from which the stones are quarried varies from a normal conglomerate to a fine-grained quartzitic rock. It includes pebbles, some of them as large as walnuts, though most of them are smaller. The rock has a bluish cast. Its bedding planes are very distinct, and layers only an inch thick may be observed. It is extremely hard and tough and resists erosion to a marked degree. It underlies Brush Mountain for miles, and for this reason the millstones are frequently known as Brush Mountain stones. The stone can not be quarried by blasting, and it is therefore extracted by hand power, with drill and hammer, plug and feathers. Millstones and drag or rider stones are the principal products made at the Virginia quarries.

The following table gives, by States, the value of the millstones, burrstones, chasers, paving blocks, and drag or rider stones produced in the United States from 1905 to 1909, inclusive:

Value of millstones produced in the United States, 1905–1909, by States.

State.	1905.	1906.	1907.	1908.	1909.
New York	$25,915	$28,848	$23,072	$18,341	$13,138
Virginia	8,186	15,611	4,684	7,954	
North Carolina	2,522	1,507	1,969	4,052	22,255
Pennsylvania	1,351	2,624	2,016	1,073	
Alabama	....	....	....	....	
Total	37,974	48,590	31,741	31,420	35,393

The following table gives the value of burrstones and millstones produced in the United States since 1880:

Value of burrstones and millstones produced in the United States, 1880–1909.

1880	$200,000	1895	$22,542
1881	150,000	1896	22,567
1882	200,000	1897	25,932
1883	150,000	1898	25,934
1884	150,000	1899	28,115
1885	100,000	1900	32,858
1886	140,000	1901	57,179
1887	100,000	1902	59,808
1888	81,000	1903	52,552
1889	35,155	1904	37,338
1890	23,720	1905	37,974
1891	16,587	1906	48,590
1892	23,417	1907	31,741
1893	16,639	1908	31,420
1894	13,887	1909	35,393

IMPORTS.

The value of the imports of burrstones and millstones into the United States increased in 1909 as compared with 1908, but the increase was slight and the importation of foreign material appears to be declining. The value of finished stones seems to fluctuate continually, having dropped from the highest record in recent years, in 1908, to a low figure in 1909. The value of the imports of burrstones and millstones, both rough and prepared, from 1905 to 1909, are given in the following table:

Value of burrstones and millstones imported and entered for consumption in the United States, 1905–1909.

Year.	Rough.	Made into millstones.	Total.	Year.	Rough.	Made into millstones.	Total.
1905	$30,478	$938	$31,416	1908	$16,075	$2,567	$18,642
1906	32,921	277	33,198	1909	22,125	465	22,590
1907	26,431	877	27,308				

GRINDSTONES AND PULPSTONES.

PRODUCTION.

The value of the grindstones and pulpstones produced in 1909 was $804,051. The industry shows a healthy recuperation from its condition during 1908, the production gaining $267,956, or almost 50 per cent in value. In the following table is given the value of grindstones and pulpstones during the five years 1905 to 1909, inclusive:

Value of the production of grindstones and pulpstones, 1905–1909.

	1905.	1906.	1907.	1908.	1909.
Grindstones	$726,536	$694,894	$846,522	$495,495	$768,651
Pulpstones	51,070	50,000	49,500	40,600	35,400
Total	777,606	744,894	896,022	536,095	804,051

The following table shows the value of grindstones and pulpstones produced in the United States from 1905 to 1909, by States. The producing States are Ohio, Michigan, West Virginia, and Colorado. Ohio maintained the leading position in 1909, producing more than five times as much as Michigan, West Virginia, and Colorado combined. The production of Michigan is important, but that of Colorado and West Virginia is very small. No production was reported from California, Missouri, Montana, and Wyoming in 1909.

Value of grindstones and pulpstones produced in the United States, 1905–1909, by States.

State.	1905.	1906.	1907.	1908.	1909.
Ohio	$644,315	$644,720	$764,276	$482,128	$679,930
Michigan	111,500	78,500	(a)	(a)	(a)
West Virginia and Colorado	[b] 21,791	[b] 21,674	131,746	53,967	[c] 124,121
Total	777,606	744,894	896,022	536,095	804,051

a Included with West Virginia, etc.
b Including a small production from Wyoming in 1905 and 1906.
c Includes Michigan.

The value of the production of pulpstones and grindstones in the United States from 1880 to 1909, inclusive, is shown in the following table:

Value of grindstones and pulpstones produced in the United States, 1880–1909.

1880	$500,000	1895	$205,768
1881	500,000	1896	326,826
1882	700,000	1897	368,058
1883	600,000	1898	489,769
1884	570,000	1899	675,586
1885	500,000	1900	710,026
1886	250,000	1901	580,703
1887	224,400	1902	667,431
1888	281,800	1903	721,446
1889	439,587	1904	881,527
1890	450,000	1905	777,606
1891	476,113	1906	744,894
1892	272,244	1907	896,022
1893	338,787	1908	536,095
1894	223,214	1909	804,051

IMPORTS

The value of the imports of pulpstones and grindstones showed a decided increase in 1909, but is below that reached a few years ago. The imports for the last five years are given in the following table:

Value of pulpstones and grindstones imported and entered for consumption in the United States, 1905–1909.

1905	$113,752	1908	$80,382
1906	134,136	1909	99,153
1907	111,495		

CANADIAN PRODUCTION.

The value of the production of grindstones in Canada during 1909 amounted to $50,944, as compared with $45,128 in 1908. The following table gives the value of Canadian production of grindstones during the last five years:

Value of production of grindstones in Canada, 1905–1909.

1905	$57,200	1908	$45,128
1906	61,624	1909	50,944
1907	60,376		

OILSTONES AND SCYTHESTONES.

PRODUCTION.

The production of oilstones and scythestones in the United States during 1909 amounted to $214,019, as compared with $217,284 in 1908. Oilstones were produced in Arkansas, Indiana, Kentucky, and Ohio, and scythestones in Michigan, New Hampshire, Ohio, and Vermont. Arkansas is the largest producer of oilstones and New Hampshire of scythestones. The following table gives the value of oilstones and scythestones produced in the United States from 1891 to 1909:

Value of oilstones and scythestones produced in the United States, 1891–1909.

1891	$150,000	1901	$158,300
1892	146,730	1902	221,762
1893	135,173	1903	366,857
1894	136,873	1904	188,985
1895	155,881	1905	244,546
1896	127,098	1906	268,070
1897	149,970	1907	264,188
1898	180,486	1908	217,284
1899	208,283	1909	214,019
1900	174,087		

THE SCYTHESTONE INDUSTRY IN NEW HAMPSHIRE.

Scythestones are manufactured by the Pike Manufacturing Company at Pike Station, in the northwestern part of New Hampshire, near Connecticut River.

The raw material from which the stones are made is a fine-grained, thinly laminated, micaceous sandstone, whose quartz grains occur in definite layers separated by thin layers of mica flakes. Associated with this material is rock in which the quartz articles occur in coarser grains and in lenses rather than in layers. The quartz particles in the rock may here and there give place entirely to argillaceous material. Where the quartz grains become coarse and irregularly disposed and where argillaceous material is present the rock is unfit for abrasive purposes and is discarded. Besides the planes of schistosity, there are developed at right angles to them well marked joint planes. Such a plane normal to the plane of schistosity is known as a "foot," and the stone between an upper and a lower "foot" is known as a "bent" of stone. After the stone is shattered by the blasting the "bent" is pried out. The quarries are not extensive in area and are bounded by stone known as "hard head," which apparently may be almost any other stone, hard to work and unfit for scythestones.

The raw material is generally found in peculiar wedge-shaped lenses striking northeast-southwest. The broaded end of the lenses is toward the southwest, and they pinch out and taper to the northeast. The methods of quarrying are briefly as follows: The covering of clay, which averages but a few feet in thickness, is plowed up, shoveled into cars, carried off a short distance, and dumped. After this surface stripping, holes are drilled with a steam drill to depths ranging from 6 to 12 feet, and the rock is loosened by blasting, the charge of powder used—from 4 to 10 pounds—varying with the depth of the hole. The rock loosened along the plane of schistosity is then pried out in big, irregularly shaped pieces. These slabs vary in thickness, but are generally less than 1 foot thick. The largest slabs thus obtained are broken up into smaller rectangular slabs, which are piled up and reserved for the winter, when quarrying is suspended and the workmen are compelled by reason of the excessive cold to work indoors. This material is known by the name of "timber." The smallest slabs are worked up at once in the warm season. They are first cut into the rough rectangular slabs known as "timber." The "timber" is split into thinner slabs, approximately the thickness of the finished stones, and then by the aid of knives and hammers these slabs are, in turn, broken into oblong rectangles, which is the raw material from which the finished scythestone is made directly.

This raw material is hauled in wagons from the quarry to the town of Pike, a mile distant, where it is ground into finished stones. The operations involved in grinding are simple. Several rough stones are together ground smooth by being pressed against a horizontally revolving wheel covered with coarse sand obtained near by. Pressure is exerted by hand or by heavy iron blocks. The individual stones are next taken and manipulated by hand until ground into the requisite shape. This is accomplished on the same wheel used in the preliminary grinding. The wheel or table on which the grinding is done is made of wood, and into it are driven steel wedges or "butts" obtained from nail factories. The grinding is thus accomplished on what amounts practically to a steel surface.

IMPORTS AND EXPORTS.

The value of the imports of hones, whetstones, and oilstones amounted to $68,018 in 1909, as compared with $44,304 in 1908. This importation was $23,714 more than that of 1908, but less than that of 1906 and 1907. The importation is in part offset by the exportation of Arkansas oilstones and New Hampshire scythestones. The value of the different imports, however, can not be given, as no separate record of them is kept. The following table shows the value of all kinds of hones, oilstones, and whetstones imported into the United States in the last five years:

Value of imports of hones, oilstones, and whetstones, 1905–1909.

1905	$65,753	1908	$44,304
1906	83,863	1909	68,018
1907	89,939		

CORUNDUM AND EMERY.

PRODUCTION.

As a producer of corundum the United States has for a time, at least, withdrawn from the field, and during 1908 and 1909 no production of corundum was reported. The production given in the following table is that of emery alone, which comes from Chester Mass., and from Peekskill, Westchester County, N. Y. The domestic production of emery in 1909, valued at $18,185, constituted but a little more than 5 per cent of the value of the imported corundum and emery. The reason for the small domestic production has been doubtless the cheaper available supply from Greece and Turkey, whence emery was imported crude as ballast to escape the import duty. The Payne-Aldrich tariff act of 1909, however, removed the duty from both grain emery and manufactured emery.

A large part of the emery imported into the United States is made into emery wheels. An interesting account of the manufacture of emery wheels at Pittsburg was published in the Iron Trade Review of August 13, 1908, to which the reader is referred for details respecting this industry.

The production of emery in the United States in 1909 amounted to 1,580 short tons, valued at $18,185, an increase in quantity of 911 tons and in value of $9,440. The value per ton, $11.50, was only 8 cents less than in 1907, but it was $1.57 less than in 1908. The figures showing value represent the value of rough material as it comes from the mines at the point of shipment. All the emery mined at Peekskill is shipped to other points for grinding and manufacture into finished forms, after which, of course, its value is greatly increased. The following table gives the quantity of corundum and emery produced in the United States since 1881. The figures for 1907, 1908, and 1909 represent the quantity and value of emery alone.

Annual production of corundum and emery, 1881–1909, in short tons.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
1881	500	$80,000	1896	2,120	$113,246
1882	500	80,000	1897	2,165	106,574
1883	550	100,000	1898	4,064	275,064
1884	600	108,000	1899	4,900	150,600
1885	600	108,000	1900	4,305	102,715
1886	645	116,190	1901	4,305	146,040
1887	600	108,000	1902	4,251	104,605
1888	589	91,620	1903	2,542	64,102
1889	2,245	105,567	1904	1,916	56,985
1890	1,970	89,395	1905	2,126	61,464
1891	2,247	90,230	1906	1,160	44,310
1892	1,771	181,300	1907	1,069	12,294
1893	1,713	142,325	1908	669	8,745
1894	1,495	95,936	1909	1,580	18,185
1895	2,102	106,256			

IMPORTS.

Imported emery comes from Asia Minor (Turkey) and the island of Naxos, Greece. According to Mr. E. L. Harris, United States Consul at Smyrna,[a] the mines in Asia Minor which are now worked are located from 50 to 200 miles southeast of Smyrna. All the visible emery has now been removed, and the cost of extraction is almost doubled from the fact that the workings are so far below the surface. Mining operations are conducted in the most primitive fashion. The ore brought to Smyrna from the deposits remote from the city is carried by camels, or, less frequently, by mules and donkeys. The value of emery at the point of shipment varies from $17 to $19 per ton. The yearly shipments average 20,000 tons from Turkey and 7,000 tons from Naxos. Grecian emery is exported through the port of Syra, where it brought $20.70 per metric ton in 1909. About 60 per cent of the material exported from Turkey and Greece goes to the United States. The table following gives the quantity and value of emery and corundum imported into the United States from all foreign sources during the last five years. In 1909 the quantity and value of both prepared and crude material increased, as well as the value of manufactured articles, and the total value showed a marked increase in 1909 over 1908.

Emery and corundum imported into the United States, 1905–1909.

Year.	Grains.		Ore and rock.		Other manufactures.	Total value.
	Quantity.	Value.	Quantity.	Value.	Value.	
	Pounds.		*Long tons.*			
1905	3,209,915	$143,729	11,073	$185,689	$18,007	$347,425
1906	4,655,668	215,357	13,841	286,386	19,339	521,082
1907	4,282,228	186,156	11,235	211,192	15,282	412,630
1908	1,735,366	89,702	8,084	146,105	12,592	248,399
1909	2,696,960	132,264	9,836	186,930	19,803	338,997

[a] U. S. Daily Cons. Repts., October 31, 1907.

CANADIAN CORUNDUM.

Canadian corundum is obtained principally from pinkish syenite and nepheline syenite in the Province of Ontario. The output comes chiefly from the Craigmont district, in Renfrew County. Early in 1909 operations were resumed by the Manufacturers Corundum Company, which obtained a lease from the Canadian Corundum Company. The old system of open cut mining is still in use. The company employs 135 men at the mine and mill, which is run only on the day shift.

The total quantity of corundum ore treated in Canada during 1909 was 35,894 tons, from which was produced 1,579 tons of grain corundum. The total shipments were 1,491 tons, valued at $157,398,[a] an increase of 36.9 per cent in quantity and of 56.7 per cent in value as compared with 1908. The following table shows the quantity and value of Canadian corundum produced during the last five years:

Production of Canadian corundum, 1905–1909, in short tons.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
1905	1,644	$149,153	1908	1,089	$100,398
1906	2,274	204,973	1909	1,491	157,398
1907	1,892	177,922			

ABRASIVE QUARTZ AND FELDSPAR.

A relatively small part of the quartz and feldspar produced in the United States is used for abrasive purposes and it has been found impracticable to distinguish in the returns of many of the producers the portion of their ouput thus used. The production of quartz and feldspar in the United States is reported in another chapter of this volume.

ABRASIVE GARNET.

PRODUCTION.

The production of garnet for abrasive purposes in 1909 amounted to 2,972 short tons, valued at $102,315, as compared with 1,996 short tons, valued at $64,620, in 1908. This was a fair increase over the production of 1908, but is nevertheless somewhat disappointing. The industry does not yet seem to have recovered from the setback it received during 1908 from overproduction, a declining market, and the invasion of the abrasive industry by artificial abrasives. The average price of garnet per ton in 1909 was $34.43, an increase of $2.06 per ton as compared with $32.37 in 1908. The garnet industry is practically confined to New York, but a small production was reported from North Carolina in 1909. The following table gives the quantity and value of abrasive garnet produced in the United States for the years 1895 to 1909:

[a] Preliminary Rept. Min. Prod., Canada, 1909.

Production of abrasive garnet, 1895–1909, in short tons.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
1895	3,325	$95,050	1903	3,950	$132,500
1896	2,686	68,877	1904	3,854	117,581
1897	2,554	80,853	1905	5,050	148,095
1898	2,967	86,850	1906	4,650	157,000
1899	2,765	98,325	1907	7,058	211,686
1900	3,185	123,475	1908	1,996	64,620
1901	4,444	158,100	1909	2,972	102,315
1902	3,926	132,820			

NOTES ON THE ABRASIVE GARNET INDUSTRY.

New York.—[a]The production of garnet for abrasive purposes is a well-established industry in the Adirondack region of New York. The seat of the industry is in Warren and Essex counties, near the upper Hudson River valley. North Creek, the terminus of the Adirondack branch of the Delaware and Hudson Railroad, is the principal point of shipment.

The garnet produced is almandite, the iron-aluminum variety with the symbol $3FeO.Al_2O_3.3SiO_2$. Ordinarily garnet has a hardness of 6.5 to 7.5, but it is claimed that the Adirondack garnet is harder than this, ranging from 7.5 to 8 in the scale, thus lying intermediate between quartz (7) and corundum (9). According to Newland,[b] the garnet is usually associated with amphibolite, which occurs in lens-shaped bodies in a country rock of acidic gneiss. The amphibole has been metamorphosed, as is usual with garnet-bearing rocks. The mineral occurs in crystals, ranging from an inch upward in diameter, and the larger crystals have been so strained and shattered by compression that they readily crumble into small fragments.

In working the deposits the country rock is broken down by the ordinary quarry methods of picking or blasting. The rock is then crushed sufficiently fine to release the garnets, and the product is washed. The garnet is recovered either by hand sorting or by mechanical means. In the past some difficulty has been encountered in separating the garnet from the accompanying hornblende, but the North River Garnet Company has overcome the difficulty by employing crushers and then concentrating on a special type of jigs.

The output is used in the shoe and wood-working industries and sold in the form of garnet paper. The mineral possesses no distinct mineral cleavage, but has a rather distinct parting parallel to the dodecahedral faces, which is usually well developed in the Adirondack mineral. This insures a smooth surface for attachment to the cloth or paper and at the same time leaves a sharp cutting edge. The resultant efficiency is said to be much greater than that of ordinary sandpaper.

The garnet produced in New York during 1909 was reported from mines near North River and Wevertown, Warren County. At the mine of the North River Garnet Company, on Thirteenth Lake, there is an immense bed of garnet rock with a quarry face nearly 150 feet high. The material is crushed and concentrated mechanically, the

[a] The notes on the garnet industry in New York have been largely compiled from the reports of D. H. Newland contained in a bulletin of the New York State Museum devoted to the mining and quarrying industry.

[b] The mining and quarry industry of New York State: Bull. New York State Mus. No. 102, 1906, p. 11.

North River Company being the only one employing mechanical methods of separation. The other firms reporting a production of garnet from New York in 1909 are H. H. Barton & Son Company and Sanders Brothers.

North Carolina.—A small quantity of garnet was reported in 1909 from near Waynesville, Jackson County, N. C.

INFUSORIAL EARTH AND TRIPOLI.

PRODUCTION.

In previous reports on the production of abrasives in the United States it has been the custom to combine the statistics of infusorial earth and tripoli, but the two substances seem to be quite different in origin and to a certain extent in their uses.

Some of the Missouri tripoli is and always has been used for abrasive purposes, but much of it is used in the manufacture of filters. The Illinois product is used in the paint industry, as a wood filler, for enameling, etc. No attempt has heretofore been made to procure from producers of tripoli a definite statement of the exact proportion used as an abrasive, nor has any attempt been made to get at the production of rough tripoli blocks worked up into filter stones. Even if this output had been found, it would be impossible to value the product on a uniform basis, and thus to obtain a reliable ratio between quantity and value, for the reason that the price of filter stones varies and is dependent not only on the size of the stones but also on the amount of work done on each. For this reason it has been decided to give simply the value of the production of infusorial earth and tripoli and to omit the quantity. In 1909 infusorial earth and tripoli were mined for the market in the following States, named in order of value of output: Missouri, Illinois, California, New York, Connecticut, and Massachusetts. Maryland reported no production in 1909.

In the following table is given the production of infusorial earth and tripoli in the United States from 1880 to 1909. The industry shows a complete revival from its depression during 1908, the production of 1909, the largest yet reported, being valued at $122,348.

Production of infusorial earth and tripoli, 1880–1909, in short tons.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
1880	1,833	$45,660	1895	4,954	$20,514
1881	1,000	10,000	1896	3,846	26,792
1882	1,000	8,000	1897	3,833	22,835
1883	1,000	5,000	1898	2,733	16,691
1884	1,000	5,000	1899	4,334	37,032
1885	1,000	5,000	1900	3,615	24,207
1886	1,200	6,000	1901	4,020	52,950
1887	3,000	15,000	1902	5,665	53,244
1888	1,500	7,500	1903	9,219	76,273
1889	3,466	23,372	1904	6,274	44,164
1890	2,532	50,240	1905	10,977	64,037
1891		21,988	1906	8,099	72,108
1892		43,655	1907		104,406
1893		22,582	1908		97,442
1894	2,584	11,718	1909		122,348

TRIPOLI INDUSTRY IN MISSOURI.

The tripoli deposits now worked in Missouri are near Seneca, Newton County, the material being known locally as "cotton rock." The deposits are the most extensive of their kind in the United States.

The following account of the tripoli industry in Missouri is quoted from a paper by Gaylord Nelson.[a]

Seneca is located on the eastern side of the Missouri-Oklahoma State line, in the southwest part of Missouri. It is on the western edge of the Ozark uplift, which includes the greater part of southwest Missouri and northwestern Arkansas and small adjacent parts of Kansas and Oklahoma. * * *

The deposits of tripoli are generally found on the tops of the hills, though some occur in the steeper bluffs, but owing to the fact that tripoli is formed by weathering processes deposits found in the bluffs are not likely to be workable. The bodies of tripoli are from 4 to 12 feet thick and lenticular in shape. They are overlain by nodules of chert, red clay, and gravel. This covering of the beds is from 3 to 6 feet in thickness and has to be stripped off by hand before the tripoli can be quarried.

At the present time there are two localities near Seneca from which the tripoli is being obtained. One of these localities is north of Seneca, about a mile, in sec. 33, T. 25 N., R. 34 W., the Missouri-Oklahoma line passing through the middle of this section. The workable deposits are located on both sides of the line. The other locality which is being worked is 8 miles east of Seneca.

In the quarries north of Seneca the tripoli is massive, showing no bedding planes, but divided by vertical and inclined joints into blocks of irregular size. These joints and seams are of such a nature that it is impossible to obtain the tripoli stone in blocks of any size, so that the output of these pits is used for grinding into tripoli flour instead of in the manufacture of filters. Nodular masses of chert occur through the tripoli locally in such quantities as to force the abandonment of the pit.

In the locality east of Seneca the tripoli is found under the same conditions as in the other quarries. The stone is, however, more massive and free from the joints which are so numerous in the other quarries. The massive character of these deposits makes them especially desirable for filter stones, for which purpose they are largely used.

The origin of the tripoli is usually considered to be from the decomposition of chert. The impure chert has been subjected to the solvent action of water, and all soluble matter—calcium carbonate, etc.—has been removed, leaving the porous siliceous material. From the nature of the origin of the deposits they are never found in the lowlands or valleys but always on the hills, where water can exert its solvent action to the best advantage.

The stone is quarried by the usual methods. The clay, gravel, and chert above the beds are stripped off by hand, and the rock is shot off in benches by the use of black powder. In the case of the stone used for filters, it is customary to drive off the benches with wedges instead of shooting them off with powder, as powder shatters the rock and renders it difficult to obtain pieces of any size.

That destined for filter stone is hauled from the quarry direct to the mill and sawed while still wet. The stone which is to be ground into flour, however, is stored in long open sheds for two or three months until thoroughly dry, as it is impossible to grind stone that contains any appreciable moisture. From these drying sheds the stone is hauled to the mill in wagons and ground.

The rough blocks for filter stones are taken direct from the quarry to the mill, where they are sawed into blocks of suitable dimensions to be turned into filter stones of various sizes and shapes. The sawed blocks are dried over coiled steam pipes before the next step, which is usually making the stone round for cylindrical or tubular filters. This rounding of the stone is accomplished by pressing the stone against a vertical revolving sandpaper disk. The ends of the block are squared to the proper length and the block is placed lengthwise and free to revolve against the revolving sandpaper disks, which are from 3 to 5 feet in diameter. The insides of these cylinders are then drilled out and the stones are ready for use in a filter. The finishing work on certain kinds of filters is also done at this mill—the casing of the stone with a nickel-plated cylinder and attaching a tube.

The machinery of the tripoli-flour mill is essentially the same as that of an ordinary wheat-flour mill. The rock from the drying sheds is delivered to the mill, passed through light jaw crushers in the basement, then elevated to bins, from which it passes through reels to upright burs. It is then sieved through silk wire bolting cloths and packed in barrels and sacks like ordinary flour. Two grades of the flour

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[a] Mining World, Sept. 11, 1909, p. 552.

are made, depending upon the fineness of the grinding. The coarser grade O. G. (once ground) will pass through a No. 60 wire-mesh screen, while the grade D. G. (double ground) will pass through a 140-wire mesh, or a No. 14 silk bolting cloth. Three colors of flour are made, depending upon the percentage of iron oxide present in the tripoli—white, cream, and rose. These colors are obtained by careful hand sorting of the blocks in the dry sheds according to the iron oxide present.

Tripoli stone is used for a number of purposes, as blotter blocks and scouring bricks, but by far the most important use is for filters. These filters are made in all sizes from the small house filter to filters having a capacity of 400 gallons per hour.

The flour is used principally as an abrasive or polisher in the metal-working trades, the finest grade being used as a jewelry polish, while the coarser grades are used as brass or steel polish. The floor is also used to some extent as an ingredient of scouring soaps. No doubt the flour has been used to some extent as an adulterant, as it is nearly pure white, without appreciable grit, and very heavy. Much of the flour produced by the Seneca mill is shipped abroad, principally to Germany and England.

The American Tripoli Company is the largest as well as the pioneer company in the industry, having erected a grinding mill in 1887. This mill, situated on the hill just east of the Missouri-Oklahoma state line, a mile north of Seneca, was enlarged and remodeled and remained in use until a year ago, when it was abandoned for the new mill built in Seneca near the Frisco Railroad. This new mill, built in 1907, is equipped with 2 coarse crushers, 5 runs of vertical burrs, 20 sieve reels, flour packets, etc. It has a capacity of 30 tons per 10-hour day; the power is furnished by a 100-horsepower steam engine. The Seneca Filter Works, established in Seneca in 1894, was absorbed by the American Tripoli Company in 1905. The combined output of these two mills is valued at about $50,000 a year.

Other companies have from time to time been organized to engage in the business, but all of these attempts have been failures. The Elijah A. Brown Tripoli Company built a small mill 3 miles south of Racine in 1907. This mill, though small, is complete for the manufacture of both filter stones and flour. Since its completion the mill has been idle.

The National Filter Company opened up quarries on 80 acres of land south of Racine. The stone was quarried and shipped to the firm's manufacturing plant in Chicago. Within the last year the company has ceased operation in the district.

INFUSORIAL EARTH.

Diatomaceous or infusorial earth resembles chalk or clay in its physical properties, but can be distinguished at once from chalk by the fact that it does not effervesce when treated with acids. It is generally white or gray in color, but may be brown or even black when mixed with much organic matter. Owing to its porosity it has great absorptive powers. Chemically it is a variety of opal.

Heretofore infusorial earth has been largely used for abrasive purposes, in the form of polishing powders, scouring soaps, etc., but of late its uses have been considerably extended. Owing to its porous nature it has been used in the manufacture of dynamite as a holder of nitroglycerine. Its porosity also renders it a nonconductor of heat and in connection with its lightness in weight has extended its use as a packing material for safes, steam pipes, and boilers and as a fireproof building material. The California product, according to Arnold and Anderson,[a] may be cut into any shape desired and, like the Missouri tripoli, may be used as a filter stone. The material is quarried for use as building stone in southern California, a use to which it seems to be well adapted, especially in that region of earth tremors, because of its elasticity and because the minimum amount of damage is likely to result from the falling of so light a material.

In Europe, especially in Germany, it has lately found extended application. It has been used in preparing artificial fertilizers, especially in the absorption of liquid manures; in the manufacture of water glass, of various cements, of glazing for tiles, of artificial stone,

[a] Bull. U. S. Geol. Survey No. 315, 1907, p. 446.

of ultramarine and various pigments, of aniline and alizarine colors, of paper, sealing wax, fireworks, gutta-percha objects, Swedish matches, solidified bromine, scouring powders, papier-mâché, and many other articles, and there is a large and steadily growing demand for it.

The material is first roasted superficially in large rooms in order to destroy all organic matter and to expel nearly all water present. It is then transferred to flame or muffle furnaces and heated at a higher temperature. Care is observed, however, not to raise the temperature too high, as its absorptive power is destroyed by overburning. It is then ground to a fine powder between rollers and sieved. At this stage it should contain less than 1 per cent of moisture. The product is put into sacks and used the same day or before moisture can be reabsorbed. Where all the precautions required for use in the manufacture of dynamite need not be observed, a prolonged drying in chambers supplied with steam pipes usually suffices. In the United States a new use of the material is reported in the manufacture of records of talking machines. For this purpose it is boiled with shellac, and the resulting prod t has the necessary hardness to give good results.

Among the new deposits of infusorial earth recently reported to the survey is one near Crown Springs, Esmeralda County, Nev.; another is in the vicinity of Port Chester, N. Y.; and a third is near Leedstown, Va. The last deposit is said to extend about 2 miles along Rappahannock River.

IMPORTS.

The infusorial earth and tripoli imported into the United States are not separately recorded by the Department of Commerce and Labor but are included with rotten stone used for similar purposes. The value of the imports of rotten stone and tripoli for the last five years has been as follows: 1905, $18,986; 1906, $25,990; 1907, $27,121; 1908, $17,252; and 1909, $24,024. No record is kept of the number of tons of this material imported.

PUMICE.

PRODUCTION.

The pumice produced in the United States in 1909 amounted to 15,103 short tons, valued at $33,439, an increase of 4,534 tons in quantity and a decrease of $5,848 in value. The average price per ton decreased $1.51, from $3.72 in 1908 to $2.21 in 1909. The production of pumice in the United States for the last five years is given in the following table:

Production of pumice in the United States, 1905–1909, in short tons.

Year.	Quantity.	Value.	Price per ton.
1905	1,832	$5,540	$3.02
1906	12,200	16,750	1.37
1907	8,112	33,818	4.17
1908	10,569	39,287	3.72
1909	15,103	33,439	2.21

IMPORTS.

The imports of pumice into the United States in 1909 were valued at $100,997, an increase of $33,903 over 1908. The value of the pumice imported into the United States for the last five years is given in the following table:

Value of pumice imported into the United States, 1905–1909.

1905	$77,489	1908	$67,094
1906	111,695	1909	100,997
1907	85,647		

NOTES ON DEPOSITS OF PUMICE.

The pumice produced in the United States comes chiefly from deposits[a] in Harlan, Lincoln, and Furnas counties in Nebraska. A small quantity of pumice was also reported from Cassia County, Idaho. Deposits of pumice are also known in South Dakota, Wyoming, Oregon, Colorado, Kansas, Oklahoma, and Iowa. A pumice deposit close to the railroad near Richfield, Sevier County, Utah, has also been reported.

The term "pumice" is applied to a form of acidic volcanic rock, which may be either massive or in a finely comminuted state. The former variety of pumice is largely imported from the Lipari Islands, a group of volcanic islands north of Sicily in the Mediterranean Sea. It owes its peculiar porous, vesicular, or pumiceous condition to the rapid expansion of included moisture or gases due to sudden release of pressure at the time of its ejection from the volcano. This expansion may be carried to such an extent that the rock is completely shattered, and the resultant finely powdered material may be carried to unknown distances by wind and air currents and then deposited in beds several feet thick. The material composing the deposits in Harlan and Lincoln Counties, Nebr., is supposed to have had the origin last described.

ARTIFICIAL ABRASIVES.

PRODUCTION.

The artificial abrasives here tabulated include carborundum, crushed steel, and alundum. A new artificial abrasive "corubin," manufactured abroad, has recently been put upon the market. The Goldschmidt Thermit Company, of New York, has kindly furnished the following information concerning this abrasive. The material is produced from the slag resulting from the reaction between aluminum and chromium oxide. It is practically pure alumina containing a trace of chromium oxide, which gives it a red color. On account of the high temperature at which it is manufactured it is free from combined moisture. It is produced in three grades—coarse, medium, and fine—and is sold only in the proportion of two parts coarse to one each of medium and fine. The total production of

[a] Mineral Resources U. S. for 1907, U. S. Geol. Survey, 1908, p. 628.

carborundum, crushed steel, and alundum in the United States since 1905 is given in the following table:

Production of artificial abrasives in the United States, 1905–1909, in pounds.

Year.	Quantity.	Value.
1905	9,820,000	$701,400
1906	11,774,300	777,081
1907	14,632,000	1,027,246
1908	8,698,000	626.340
1909	20,468,000	1,365,820

CARBORUNDUM.

Carborundum is manufactured by a single firm in the United States, the Carborundum Company of Niagara Falls, N. Y. The foreign demand for this abrasive has increased so rapidly within the last few years that the company has constructed a plant at Dusseldorf, Germany, for the manufacture of carborundum wheels and abrasive articles. This plant began operations in February, 1907.

Carborundum is manufactured by fusing a mixture of pure granulated coke, very pure glass sand, and sawdust. The coke is the carbonaceous residue from the distillation of petroleum; the sand used is the purest glass sand. The sawdust is added mainly to make the mixture porous and thus to avoid explosions of the carbon monoxide produced during the reaction. The fundamental reaction takes place between the sand (silica) and the coke (carbon), resulting in the production of carbide of silicon, or carborundum. In 1909 the plant of the Carborundum Company was enlarged by the erection of a four-story building, which will be utilized for additional furnaces and for the mixing and the wheel-molding departments of the company. No important changes were introduced in the method of manufacture. During a run which lasts thirty-six hours each furnace consumes 2,000 horsepower. The voltage, starting at about 250, is lowered as the resistance decreases until it comes down to a voltage of about 185. The carborundum crystals are crushed under manganese steel rollers in a circular pan of the same material. The crushed product is then treated in a bath of sulphuric acid to dissolve the minute particles of steel that have been cut from the rolls and the pan. This method of removing the steel has been found more satisfactory than the method of removing it by magnets. After the carborundum has been washed to free it from acid it is screened into different grades and is then ready for manufacture.[a]

In a recent article in the Industrial World[b] it is stated that—

The Carborundum Company at Niagara Falls, N. Y., is operating its plant at capacity, using 10,000 horsepower of electric current continuously. The new abrasives recently placed on the market by the company are aloxite, a product for steel grinding which is successfully used in machine shops, as it does not heat the tool or draw the temper; samite, an abrasive for cutting aluminum which does not glaze or fill when used on aluminum or other fibrous metals; and carborundum fire sand, a chemical compound of carbon and silicon which is mixed with a binding material, silicate of soda, of 52° Baumé, which is dissolved in water before being added to the fire sand. The mixture is made plastic and is molded to the interior of a furnace for a lining. It is understood that this lining will withstand very severe conditions.

[a] Mineral Industry, 1909, pp. 84–85.
[b] Parker, Frank L., Industrial World, Nov. 28, 1910.

ALUNDUM.

The abrasive known as "alundum" is prepared by the Norton Company, at Niagara Falls, N. Y., by melting calcined bauxite in specially designed electric furnaces. For calcining the bauxite the company uses a 60-foot rotary calciner with a capacity of 40 tons a day.

The ore after calcination is ready for the electric furnaces. These are conically shaped pots, water-jacketed, which stand on cars and are heated by vertical electrodes, which are gradually raised as the molten bauxite fills the furnace.

In the furnace room 2,000 electric horsepower are used. It is said that the temperature attained in the furnace ranges from 5,000° to 6,000° F. The dimensions of the furnaces are so calculated that the fusion shall not extend to the water-cooled shell. During the fusion iron is reduced from the bauxite as a result of the reducing action of the electrodes. This iron, containing 5 to 12 per cent silicon, is sold to the steel makers. These masses, which are called "pigs," each contain about 3 tons of abrasive material.

After fusion is completed, the furnace is taken to a position under an electric crane, which removes the solidified mass and places it on the cooling floor until it is cool enough to handle. The mass is then broken up and fed to a crusher, after which the alundum passes through a reel which removes all the fine dust, which is re-fused. The product which has gone over the reel is passed over a sorting belt, where the material not up to the standard is picked out. The resulting product, in fragments about the size of a man's fist, is then loaded on cars and sent to the company's plant at Worcester, Mass., where it is subjected to the various operations necessary to shape it into alundum wheels.

Alundum has been recently used as a refractory material. It melts at 2,300° C., and has a very low coefficient of expansion, if it has any at all. It is, moreover, very inert chemically, and tests made in the basic open-hearth furnaces show that it is not appreciably affected by slags. Used as the lining of a Deville furnace it does not show deterioration after repeated burns at 1,800° C. It remains to be proved just how much better alundum is than other standard refractories, as its cost will necessarily be high. It is believed, however, that it will be of great value for many special purposes.

CRUSHED STEEL.

The method of manufacturing crushed-steel abrasives has been described by M. M. Kann, secretary and treasurer of the Pittsburg Crushed Steel Company,[a] and by Pratt.[b]

In the manufacture of crushed-steel abrasives, high-grade crucible steel is heated to nearly white heat and quenched in a bath of cold water. The fragments of steel thus produced are crushed to particles varying from fine powder up to pieces one-sixth of an inch or more in diameter. The crushed product is then classified and tempered, and is known as "diamond crushed steel," "diamond steel emery," and "steelite."

Crushed steel is used chiefly in the stone, brick, glass, and metal trades, the size of the steel used depending on the character of the stone to be cut, rubbed, ground, or polished.

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[a] Proc. Am. Assoc. Adv. Sci., Pittsburg meeting, July, 1903.
[b] Mineral Resources U. S. for 1903, U. S. Geol. Survey, 1904, p. 1013.

ARSENIC.

By Frank L. Hess.

PRODUCTION AND IMPORTS.

In 1909, as in 1908, the only arsenic produced in the United States was that recovered in the form of white arsenic (As_2O_3) as a by-product in smelting. During 1909 white arsenic was saved at three smelters. Besides the arsenic-saving plant of the American Smelters Securities Company, at Everett, Wash., and that of the Anaconda Copper Mining Company, at Anaconda, Mont., a new plant was put up by the United States Smelting Company, at Midvale, Utah. The last company, which began producing during the year, smelts large quantities of Utah lead ores, which are highly arsenical, and from the flue dusts made in smelting these ores the arsenic is saved.

The arsenic mines at Brinton, Floyd County, Va., and at Mineral, Wash., did not operate, owing to the low price of white arsenic.

The total quantity of arsenic saved by the three smelters during 1909 amounted to 2,428,313 pounds, or 1,214 short tons, valued at $52,946. The average prices received by the companies ranged from 2.05 to 2.4 cents per pound. The price in New York ranged around 3 cents per pound. The highest average monthly price was 3.25 cents per pound in January; the lowest, 2.725 cents per pound in October. The average price for the year was 2.97 cents per pound.[a]

The United States imported much more arsenic than it saved during the year, but most of the imported arsenic was in the form of sulphide.

The production and importation of arsenic, white arsenic, and arsenic sulphides and of Paris green and London purple since 1901 are given in the following table:

Production and imports of arsenic, 1901–1909.

Years.	Production of white arsenic.		Imports.			
			White arsenic, metallic arsenic, and arsenic sulphides.		Paris green and London purple.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (pounds).	Value.
1901	300	$18,000	3,495	$316,525		
1902	1,353	81,180	4,055	280,055		
1903	611	36,691	4,179	294,602		
1904	36	2,185	3,400	243,380	28,498	$985
1905	754	35,210	3,838	256,540	44,931	1,118
1906	737	63,460	3,987	350,045	311,293	21,347
1907	1,751	163,000	5,164	574,998	133,422	21,919
1908	(a)		4,964	430,400	195,000	30,764
1909	1,214	52,946	4,036	303,728	183,765	20,370

a There were only two producers of arsenic in the United States in 1908, so that the figures of production may not be given.

The imports came from Canada, Europe, and Mexico.

a Eng. and Min Jour., vol. 89, January 8, 1910, p. 137.

PRICES.

A large part of the white arsenic produced and imported is made into Paris green for use an as insecticide. The prices for Paris green have been held at high figures by the few manufacturers. Prices are said to be fixed in advance of the season. During 1909 prices from January to the middle of July, as quoted by the Oil, Paint, and Drug Reporter, of New York, were as follows:

Prices of Paris green during 1909, New York, cents per pound.

	1909	
	Before July 15.	July 15 to Dec. 31.
In bulk	21½	17
100-pound to 175-pound packages	22	17½
14, 28, and 56 pound packages	23	18½
2 and 5 pound packages	23½	19
1-pound packages	24½	20
½-pound packages	25½	21
¼-pound packages	26½	22

The cause of the fall in prices is not altogether clear, but the formation of a company to establish an independent factory at Norfolk, Va., which was to make Paris green from white arsenic made at the Brinton (Va.) arsenic mine, was nearly coincident with the decline.

Paris green is protected by a duty of 15 per cent ad valorem.

BORAX.

By Charles G. Yale.

PRODUCTION.

In 1909 the production of borax in the United States was 41,434 short tons, valued at $1,534,365, an increase in quantity, as compared with 1908, of 16,434 tons, and in value of $559,365. The quantity stated is the crude material mined and the value is fixed according to the percentage of anhydrous boric acid in the ore. All the output in 1909 was derived from two mines in Inyo and Los Angeles counties, Cal. Only colemanite or borate of lime is now being mined in California, and this varies so greatly in its content of anhydrous boric acid, not only in different mines, but in any single mine, that it is necessary to determine the percentage of this acid in the ore in order to fix the value of the output.

The statistics of production of borax in California from 1895 to 1909, inclusive, are given in the following table, the values for the years 1903 to 1909, inclusive, being based on the boric-acid content of the tonnage of crude borate of lime, or colemanite:

Production of borax in California, 1895–1909.

1895..short tons..	5,959	$595,900	1903..short tons..	[b] 34,430	$661,400
1896.......do....	6,754	675,400	1904.......do....	[b] 45,647	698,810
1897.......do....	8,000	1,108,000	1905.......do....	[b] 46,334	1,019,154
1898.......do....	8,000	1,120,000	1906.......do....	[b] 58,173	1,182,410
1899.......do....	20,357	1,139,882	1907.......do....	[b] 52,850	1,121,520
1900.......do....	25,837	1,013,251	1908.......do....	[b] 25,000	975,000
1901.......do....	23,231	1,012,118	1909.......do....	[b] 41,434	1,534,365
1902.......do....	[a] 20,004	2,538,614			

IMPORTS.

The following table shows the imports of borax and borates into the United States from 1902 to 1909, inclusive:

Imports of borax and borates into the United States, 1902–1909, in pounds.

Year.	Borax.		Borates, calcium and sodium (crude) and refined sodium borate.		Boric acid.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1902	684,537	$20,795	186,807	$12,002	822,907	$30,439
1903	68,978	5,727	146,654	13,280	693,619	28,011
1904	153,952	10,569	89,447	6,630	708,815	27,658
1905	166,960	8,802	20,395	1,626	676,105	22,372
1906	791,425	27,343	57,711	2,436	986,021	33,200
1907	2,268,065	77,258	2,959	175	534,524	23,547
1908	641,632	22,058	40	4	385,064	14,702
1909	7,124	1,023	20,284	1,956	265,985	8,708

[a] Refined product, including 2,600 short tons of crude, valued at $91,000.

[b] Crude product.

BORAX INDUSTRY IN 1909.

In view of the fact that the mining of the crude material is confined to two localities, both in the State of California, no extended review of the borax industry in 1909 seems desirable. The principal source of production is the Lila C. mine, in the Death Valley section of Inyo County. From this property, owned by the Pacific Coast Borax Company, the larger part of the colemanite mined is shipped directly to the company's refineries at Bayonne, N. J., and Alameda, Cal., but some of lower grade is calcined at the mine before shipment in order to concentrate it and to reduce freight costs. The other productive mine is that of the Sterling Borax Company, near Lang station, in Los Angeles County. This property first became productive in 1908. Its product is colemanite, which is shipped to refineries as mined without previous concentration or other treatment. The only other mines in the State showing activity in 1909 were those of the Russell Borate Company in Ventura County, where considerable development was done on two claims, but no ore was mined on a commercial scale. Since the close of 1909 this property has become productive. Most of the old mines of the State, which were closed in 1907 at the time of the sudden drop in prices, still remain idle with little prospect of starting up again, for the present, at least. Most of these properties mined low-grade "marsh" material, which no longer pays. Since the colemanite mines have been worked on a large scale, the marsh or dry lake deposits have been neglected. Borax, instead of being made in a crude manner in the marshes, is now made exclusively in the refineries of the large borax companies in California and at eastern points.

New sources of consumption are constantly being sought by the producing companies. About one-half the borax consumed is used in the enameling industry, for making kitchen and sanitary ware. Each year some new use for it is found, and efforts are being made to stimulate its use for all possible purposes.

The imports of foreign material continue to decrease, the needs of the United States being fully met by the output of the California mines. The greatest sources of the world's supply of this material are California, Chile, Peru, and Asia Minor.

FLUORSPAR AND CRYOLITE.

By Ernest F. Burchard.

FLUORSPAR.

PRODUCTION.

The total quantity of domestic fluorspar reported to the Survey as marketed in the United States in 1909 was 50,742 short tons, valued at $291,747, as compared with 38,785 short tons, valued at $225,998, produced in 1908.

Three States, Colorado, Illinois, and Kentucky, and the Territories, Arizona and New Mexico, produced fluorspar in the year 1909, New Mexico having reported a production for the first time. The production in Colorado decreased; that of Illinois and Kentucky showed an increase. Colorado produced gravel spar, New Mexico lump and gravel, and Arizona marketed lump spar. The total quantity produced in these States was 1,090 short tons, valued at $6,263, an average price of $5.75 per ton. With reference to the Colorado and New Mexico product, it should be stated that the value reported to the Survey represents the value on board cars at the railroad shipping points and includes the cost of a long wagon haul—$1.50 to $3 per ton. In 1909 Illinois produced 29,880 short tons of gravel spar, valued at $135,366, or $4.53 per short ton on board cars. In this connection it should be remarked that the largest producing fluorspar mines in this State are near railroad or river transportation, therefore the cost of long wagon hauls has not entered into the reported value of this product. The sales of lump spar in Illinois were 4,667 short tons, valued at $23,625, or $5.06 per ton. The ground spar sold in this State amounted to 7,305 short tons, valued at $73,260, or $10.03 per ton. Kentucky reported total sales of 7,800 short tons of spar, valued at $53,233, distributed as follows: Four thousand eight hundred and thirty-five short tons of gravel spar, valued at $25,253, or $5.22 per ton; 336 short tons of lump spar, valued at $2,083, or $6.20 per ton, and 2,629 short tons of ground spar, valued at $25,897, or $9.85 per ton. The stocks of fluorspar reported on hand December 31, 1909, were as follows: Colorado, 10 tons; Illinois, 1,504 tons; and Kentucky, 10,116 tons, a total of 11,630 tons.

Although the fluorspar industry recovered to some extent from the business depression that affected mining and manufactures so greatly in 1908 it does not appear, upon comparison of the total quantities sold in each of the last three years, that the business of the year 1909 quite fulfilled the expectations of the majority of fluorspar producers. The relative curtailment in production is more striking when viewed in relation to the production of open-hearth steel. It is estimated that fully 80 per cent of American fluorspar, mainly in the gravel form, is consumed in the manufacture of basic open-hearth steel. The decrease in the production of basic open-hearth steel in 1908 as compared with 1907 was over 30 per cent, and the decrease in the quantity of fluorspar marketed was nearly 22 per cent, but with an increase in production of basic open-hearth steel in 1909 of more than 86 per cent over that of 1908 the increase in the total quantity of fluorspar marketed amounted to only 30.8 per cent, although the increase in gravel spar amounted to nearly 44 per cent. In 1909 there were 3,138,157 tons more of basic open-hearth steel produced than in 1907, an increase of 30.4 per cent, yet in 1909 there were only 1,256 tons more spar marketed, or an increase of 2½ per cent. From these figures it may be inferred that the domestic production of fluorspar had not, up to the close of 1909, been materially affected by the duty of $3 per ton imposed by the Payne-Aldrich bill on imported fluorspar. Probably the industry in 1910 will more accurately reflect the influence of the tariff, since unusually large quantities of spar are believed to have been shipped to the United States just before the tariff went into effect.

It has been estimated that the cost of gravel fluorspar imported into this country from the English waste dumps of Derbyshire lead mines, including the import duty of $3, is $7.38 to $7.74 per ton laid down at Pittsburg. Prior to the passage of the tariff act of 1909 it sold at Pittsburg at $5.85 per ton. Domestic unwashed gravel spar can be sold at Pittsburg for about $7, but at Philadelphia it can not be sold under $8 or $9 per ton, whereas the English spar, inclusive of tariff, costs $6.04 to $6.40 per ton laid down at that city. Thus the American fluorspar producers have an advantage at most of the open-hearth steel furnaces, since few furnaces are sufficiently near Atlantic ports to take advantage of English importations. The effect of English competition will be felt, however, until the large stock imported prior to the enactment of the tariff is exhausted and American producers are able to meet the demand.

The following table shows the fluctuations in the production of open-hearth steel in 1907, 1908, and 1909. These fluctuations have an important bearing upon the market for fluorspar.

Production of open-hearth steel in 1907–1909, in long tons.[a]

	Basic.	Acid.	Total.
1907	10,279,315	1,270,421	11,549,736
1908	7,140,425	696,304	7,836,729
1909	13,417,472	1,076,464	14,493,936

[a] Ann. Statist. Rept. Am. Iron and Steel Association, Philadelphia, Pa., July 25, 1910.

The following table gives the quantities and values of the different grades of fluorspar marketed in the United States in 1908 and 1909:

Fluorspar marketed in 1908 and 1909, in short tons.

States.	Gravel.		Lump.		Ground.		Total quantity.	Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.		
1908.								
Colorado	[a] 735	$4,518					735	$4,518
Illinois	21,332	96,315	6,189	$33,267	4,206	$43,256	31,727	172,838
Kentucky	2,840	14,226	307	1,828	3,176	32,588	6,323	48,642
Total	24,907	115,059	6,496	35,095	7,382	75,844	38,785	225,998
1909.								
Colorado	[b] 1,090	6,263					1,090	6,263
Illinois	29,880	135,366	4,667	23,625	7,305	73,260	41,852	232,251
Kentucky	4,835	25,253	336	2,083	2,629	25,897	7,800	53,233
Total	35,805	166,882	5,003	25,708	9,934	99,157	50,742	291,747

[a] Includes a small production of lump spar from Arizona.
[b] Includes a small production of gravel spar from New Mexico and of lump spar from Arizona.

The annual production of fluorspar in the United States since 1883 is given in the following table:

Production of fluorspar in the United States, 1883–1909, in short tons.

Years.	Quantity.	Value.	Years.	Quantity.	Value.
1883	4,000	$20,000	1897	5,062	$37,159
1884	4,000	20,000	1898	7,675	63,050
1885	5,000	22,500	1899	15,900	96,650
1886	5,000	22,000	1900	18,450	94,500
1887	5,000	20,000	1901	19,586	113,803
1888	6,000	30,000	1902	48,018	271,832
1889	9,500	45,835	1903	42,523	213,617
1890	8,250	55,328	1904	36,452	234,755
1891	10,044	78,330	1905	57,385	362,488
1892	12,250	89,000	1906	40,796	244,025
1893	12,400	84,000	1907	49,486	287,342
1894	7,500	47,500	1908	38,785	225,998
1895	4,000	24,000	1909	50,742	291,747
1896	6,500	52,000			

INCREASED USES.

According to Fohs the use of fluorspar is on the increase in the manufacture of glass, enameled and sanitary ware, electrolytic refining of antimony and lead, the production of aluminum, and especially in the iron and steel industries, where the value of fluorspar added in small quantities to limestone flux is becoming more and more appreciated. The increase in the number of open-hearth furnaces, and hence the increased production of basic open-hearth steel is encouraging, but in the manufacture of hydrofluoric acid there was an apparent falling off in demand for fluorspar in 1909.

NEW DEVELOPMENTS.

Kentucky.[a]—With the prospects of a broader market and the possibility of better prices there was during 1909 renewed activity among Kentucky mining companies. The Nancy Hanks shaft was sunk to 340 feet, finding the spar vein 6 feet wide at that depth, with

[a] Fohs, F. Julius, Fluorspar: The Mineral Industry during 1909, p. 262.

a 9-foot shoot at the 330-foot level. The Kentucky Fluorspar Company, the Indiana and Kentucky Fluorspar and Lead Mining Company, the Franklin Mining Company, and other firms and individuals reported the discovery and development of several promising veins of spar, ranging from 6 to 20 feet wide.

Illinois.[a]—The Rosiclaire mine in Illinois was developed extensively underground and the mill was remodeled, with the addition of two new Foust jigs, and was prepared for a largely increased output in 1910. The Fairview Fluorspar and Lead Company sunk its main incline to a depth of 520 feet, and reports that at the 460-foot level a 20-foot shoot of fluorspar was opened, and that the old No. 1 shaft was reopened and a 20-foot shoot was mined.

Colorado.—Very little new development was done in Colorado beyond that necessary for the assessment work on claims. Only a comparatively small quantity of fluorspar was produced in this State, the entire production coming from the Jamestown district. The moderate prices paid for spar at present, in conjunction with the long and expensive haul to railroads, make it almost impossible for miners to earn current wages mining fluorspar. The opening of deposits in southern New Mexico, more accessible to railroad and enjoying a favorable freight rate to the market at Pueblo, Colo., has been the chief factor in holding down the price for fluorspar in the Rocky Mountain area this year.

New Mexico.—Fluorspar has long been known to occur in the vicinity of Silver City and Deming, N. Mex., but only recently has it been found in sufficient quantities for exploitation. The American Fireman's Mining Company, of Kansas City, Mo., in prospecting for gold on properties situated 9½ miles northnortheast of Deming, N. Mex., in the foothills of Cooks Range, has opened a number of fluorspar veins that give promise of yielding nearly if not quite sufficient spar to supply the western market for several years.

The fluorspar occurs in fissure veins cutting altered diorite porphyry in close proximity to a mass of Ordovician limestone and sandstone that is intruded by and folded into the porphyry.

The veins range from less than 1 foot to more than 12 feet in thickness, but generally from 2 to 4 or 5 feet. The veins strike a little north of east, and ten to twelve distinct veins have been opened, some of which have been worked for distances as great as 100 feet, and to depths of 10 to 80 feet. The spar is hauled by wagons 6 miles to Mirage, a station on the Atchison, Topeka and Santa Fe Railway, and is shipped to Pueblo, Colo.

The fluorspar obtainable here is of high grade. It is not subjected to any mechanical concentration, and the hand cobbed and sorted product shipped in 1909 carried between 90 and 95 per cent calcium fluoride (CaF_2). The spar brings $5.25 per short ton f. o. b. cars at Mirage, based on at least 90 per cent CaF_2. According to contract a penalty of 20 cents per ton is deducted for each per cent of CaF_2 that the spar carries below 90 per cent, but no premium is paid unless the spar contains more than 95 per cent CaF_2.

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[a] Fohs, F. Julius, op. cit.

IMPORTS.

Heretofore fluorspar has been imported into the United States duty free, and it has therefore been impossible to obtain the statistics of the importations. Large quantities of gravel spar produced at a low cost from the tailings of lead mines and from the gob in abandoned mines in England have been shipped to this country as ballast at a very low freight rate. The material thus produced is high in silica, and is almost entirely consumed by open-hearth steel makers. Before 1909 spar from England has competed with American fluorspar as far west as Pittsburg and practically fixed the market price at that point. As explained on a preceding page, conditions are now reversed, and a decided decrease in the imports of foreign fluorspar is probable.

The imports of fluorspar entered for consumption into the United States in 1909 were 6,971 short tons, valued at $26,377, as compared with an estimated quantity of about 20,000 tons imported from Great Britain and all other countries in 1908.

CRYOLITE.

IMPORTS AND PRICES.

No cryolite was reported to have been produced in the United States in 1909. Cryolite is aluminum-sodium fluoride and is used chiefly in the manufacture of sodium salts, of opal and alabaster glass, of porcelain and enameled ware, and as a flux in the electrolytic aluminum process. The mineral is quarried in Greenland, and 1,278 long tons, valued at $18,427, were imported into the United States in 1909, as compared with 1,124 long tons, valued at $16,445, in 1908.

LITERATURE ON FLUORSPAR AND CRYOLITE.

For details as to occurrence, geologic relations, mining developments, and notes on the technology of the preparation and uses of fluorspar the reader is referred to the following papers:

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GYPSUM.

By Ernest F. Burchard.

PRODUCTION.

The quantity of gypsum mined in 1909 was 2,252,785 short tons, an increase of nearly 31 per cent over the production of 1908, which was 1,721,829 short tons, and an increase of more than 28 per cent over that of 1907, which was 1,751,748 short tons. The gypsum sold without calcining and used principally as land plaster and as an ingredient in Portland cement and in paint showed a large increase in quantity, but a loss of about 11 cents per ton in value; but the material calcined for plaster showed both a large increase in quantity and an increase of 30 cents per ton in selling price at the mills. The total value of gypsum and gypsum products in 1909 was $5,906,738, as compared with $4,075,824 in 1908, an increase of $1,830,914, or 44.9 per cent.

Gypsum was produced in 16 States and 2 Territories besides Alaska, and the total number of mills reporting in 1909 was 79, as compared with 79 in 1908. The largest production was reported from New York, Michigan and Iowa occupying second and third place. Practically every State enjoyed a share of the increase in production of gypsum in 1909. In Arizona 1 additional gypsum mine was opened, the product being shipped to California for treatment; Montana became a producer after a lapse of two years; 1 additional plant reported production of plaster in Nevada; in New York there were 3 plants less and in Oklahoma there was 1 plant less in operation than in 1908, but the production from each State was greater in 1909 notwithstanding.

The statistics of gypsum production for 1909 were collected by the United States Geological Survey in cooperation with the Bureau of the Census, and the compilation of the replies to the numerous and detailed inquiries contained in the general census schedule has delayed the publication of the statistics far beyond the time at which the Geological Survey usually presents them to the public. In its forthcoming reports on manufactures the Bureau of the Census will devote a section to the gypsum industry, and it is expected that the thoroughness with which the census report will deal with the manufacture of gypsum products will more than compensate for the delay in publication of the data presented herewith.

The table following gives the statistical data regarding the gypsum industry in 1908 and 1909, by States.

Production of gypsum in the United States in 1908 and 1909, by States and uses, in short tons.

1908.

State.	Number of mills reporting.	Total mined.	Sold without calcining.				Sold as calcined plaster.		Total value.
			Ground for land plaster.		For Portland cement, paint, bedding plate glass, and other purposes.		Quantity.	Value.	
			Quantity.	Value.	Quantity.	Value.			
Alaska, Arizona, Colorado, Idaho, New Mexico, South Dakota, and Utah.	12	129,440	1,573	$3,890	2,633	$9,469	101,274	$416,254	$429,613
California, Nevada, and Oregon	12	93,794	4,195	17,151	3,282	8,935	64,775	345,652	371,738
Iowa	6	240,270	1,984	3,676	19,960	26,429	158,043	535,540	565,645
Kansas	7	130,184	3,162	5,679	24,064	27,047	80,523	248,613	281,335
Michigan	7	327,810	11,414	13,381	40,324	53,673	192,403	424,874	491,929
New York	15	318,046	5,712	14,255	95,146	171,747	160,930	574,757	760,758
Ohio and Virginia	4	178,904	9,632	33,591	9,260	19,988	125,167	426,426	480,009
Oklahoma and Texas.	13	272,193	....	....	[a]14,362	16,721	216,350	583,141	599,865
Wyoming	3	31,188	....	....	....	....	26,152	94,935	94,932
	79	1,721,829	37,672	91,623	209,031	334,009	1,125,617	3,650,192	4,075,824

1909.

State.	Number of mills reporting.	Total mined.	Ground for land plaster: Quantity.	Ground for land plaster: Value.	For Portland cement, etc.: Quantity.	For Portland cement, etc.: Value.	Calcined plaster: Quantity.	Calcined plaster: Value.	Total value.
Alaska, Arizona, Colorado, Montana, New Mexico, South Dakota, and Utah.	15	191,845	116	$782	3,411	$14,400	126,563	$544,605	$559,787
California, Nevada, and Oregon	11	133,042	5,824	19,479	24,654	44,727	78,977	487,421	551,627
Iowa	6	319,577	9,676	14,633	8,452	11,466	188,389	629,503	655,602
Kansas	7	137,697	[b]5,219	10,470	34,891	36,664	78,546	274,787	321,921
Michigan	8	394,907	11,890	18,772	45,781	60,186	344,171	1,134,389	1,213,347
New York	12	403,929	8,950	21,505	138,515	214,410	218,159	796,735	1,032,650
Ohio and Virginia	4	289,517	7,906	18,054	20,628	49,263	185,591	600,631	667,948
Oklahoma and Texas.	13	338,526	(c)	(c)	15,942	17,698	258,338	753,439	771,137
Wyoming	3	43,745	....	....	....	....	35,303	132,719	132,719
	79	2,252,785	49,581	103,695	292,274	448,814	1,514,037	5,354,229	5,906,738

[a] Includes a small quantity of ground material from Texas. [b] Includes Oklahoma. [c] Included in Kansas.

The tables following show the quantity of crude gypsum mined in the United States by years since 1880, the marketed output classified as to uses, and the disposition of the marketed product:

Crude gypsum mined in the United States, 1880–1909.

	Short tons.		Short tons.		Short tons.
1880	90,000	1890	182,995	1900	594,462
1881	85,000	1891	208,126	1901	633,791
1882	100,000	1892	256,259	1902	816,478
1883	90,000	1893	253,615	1903	1,041,704
1884	90,000	1894	239,312	1904	940,917
1885	90,405	1895	265,503	1905	1,043,202
1886	95,250	1896	224,254	1906	1,540,585
1887	95,000	1897	288,982	1907	1,751,748
1888	110,000	1898	291,638	1908	1,721,829
1889	267,769	1899	486,235	1909	2,252,785

Production of gypsum in the United States, 1905–1909, classified as to uses.

Year.	Sold without calcining.					
	Ground for land plaster.			For Portland cement, paint, bedding plate glass, and other purposes.		
	Quantity, in short tons.	Value.	Average price per ton.	Quantity, in short tons.	Value.	Average price per ton.
1905	40,196	$74,280	$1.85	67,105	$106,041	$1.58
1906	62,671	157,292	2.50	186,999	460,545	2.46
1907	46,851	115,841	2.47	232,546	424,227	1.82
1908	37,672	91,623	2.43	209,031	334,009	1.60
1909	49,581	103,695	2.09	292,274	448,814	1.54

Year.	Sold as calcined plaster.			Total value.
	Quantity, in short tons.	Value.	Average price per ton.	
1905	736,708	$2,848,906	$3.87	$3,029,227
1906	899,581	3,220,138	3.58	3,837,975
1907	1,125,301	4,402,196	3.91	4,942,264
1908	1,125,617	3,650,192	3.24	4,075,824
1909	1,514,037	5,354,229	3.54	5,906,738

Disposition of gypsum in the United States, 1908–9, by uses, in short tons.

	1908		1909	
	Quantity.	Value.	Quantity.	Value.
Sold crude:				
For Portland cement	187,680	$305,745	260,433	$402,830
For paint material	1,281	1,300	(a)	(a)
For plaster material	12,286	15,124	29,784	44,323
As land plaster	37,972	91,833	49,581	103,695
For other purposes	7,484	11,630	b 2,057	1,661
Sold calcined:				
For dental plaster	174	636	2,728	73,600
As plaster of Paris, wall plaster, etc	1,074,229	3,508,520	c 1,438,706	5,070,334
To glass factories	14,412	41,102	13,869	35,208
For Portland cement and other purposes	36,802	99,934	58,734	175,087
	1,372,320	4,075,824	1,855,892	5,906,738

a Included in "For other purposes."
b Includes some paint material.
c Includes some dental plaster and other gypsum products from Kansas, Oklahoma, and Texas.

IMPORTS.

The gypsum which is imported into the United States comes, except a few hundred tons annually from France and Great Britain, almost wholly from Nova Scotia and New Brunswick, and enters the ports of the New England and North Atlantic States, over one-half of it entering the port of New York. This imported gypsum is nearly all calcined and converted into wall plasters by plants along the seaboard as far east as Red Beach, Maine. A small quantity of the material is used crude as land plaster, and some is mixed in patent fertilizers.

The Payne-Aldrich tariff reduced the import duties from 50 cents to 30 cents per ton on crude gypsum, and from $2.25 to $1.75 per ton on the ground or calcined product. The increase in total value of gypsum and gypsum products imported into the United States in 1909 over the value of the imports in 1908 was a little less than 20 per cent.

The following table shows the imports for consumption into the United States from 1905 to 1909, inclusive:

Gypsum imported and entered for consumption in the United States, 1905–1909, in short tons.

Year.	Ground or calcined.		Unground.		Value of manufactured plaster of Paris.	Total value.
	Quantity.	Value.	Quantity.	Value.		
1905	3,889	$20,883	399,230	$402,328	22,948	$446,152
1906	3,587	22,821	436,999	464,725	21,183	508,729
1907	1,979	12,825	453,911	486,205	36,628	535,658
1908	1,889	12,825	300,158	314,845	26,733	354,403
1909	3,437	21,799	350,160	376,790	26,548	425,137

WORLD'S PRODUCTION.

The following table gives the world's production of gypsum from 1904 to 1908, inclusive:

World's production of gypsum, 1904–1908, in short tons.

Year.	France.		United States.		Canada.	
	Quantity.	Value.	Quantity.	Value.	Quantity.[a]	Value.[a]
1904	1,749,875	$2,916,453	940,917	$2,784,325	340,761	$372,924
1905	1,414,596	2,343,943	1,043,202	3,029,227	435,789	581,543
1906	1,517,603	2,423,615	1,540,585	3,837,975	417,755	591,828
1907	1,559,685	2,598,828	1,751,748	4,942,264	485,921	646,914
1908	1,564,196	2,607,816	1,721,829	4,075,824	340,964	575,701

Year.	Great Britain.		German Empire.		Algeria.		Cyprus.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.[b]	Value.[b]
1904	262,086	$354,138	25,095	$17,307	33,951	$93,287	12,449	$31,721
1905	286,169	400,717	....	....	38,297	98,420	17,890	42,499
1906	252,030	362,761	....	....	30,809	85,446	23,069	55,658
1907	263,779	431,313	....	....	29,101	75,907	27,114	68,146
1908	255,714	431,551	....	....	28,109	66,537	23,511	57,561

[a] Quantity sold. [b] Exports.

CHARACTER OF GYPSUM.

Pure gypsum is a hydrous lime sulphate having a chemical formula $CaSO_4.2H_2O$. This, when reduced to percentages of weight, corresponds to the following composition:

Gypsum ($CaSO_4.2H_2O$)	Lime sulphate ($CaSO_4$)	Lime (CaO) .... 32.6 Sulphur trioxide (SO_3) 46.5	79.1
	Water (H_2O)		20.9

Few deposits of rock gypsum large enough to be worked for plaster are, however, even approximately as pure as this. Gypsum, as excavated for a plaster plant, will usually carry varying and often high percentages of such impurities as clay, limestone, magnesian limestone, iron oxide, and silica. Where the material occurs in an earthy, granular condition, it is known as gypsite, and this form of the mineral may carry 10 to 20 per cent of impurities.

Analyses.—The following analyses of rock gypsum and gypsite from various localities [a] are fairly representative of the materials used for plaster in different States. Silica, alumina, iron oxide, lime carbonate, and magnesium carbonate constitute the characteristic impurities.

Analyses of gypsum and gypsite.

	Silica (SiO_2).	Alumina (Al_2O_3) and iron oxide (Fe_2O_3).	Lime carbonate ($CaCO_3$).	Magnesium carbonate ($MgCO_3$).	Lime sulphate (CaSO).	Water (H_2O).
1	0.40	0.19	0.25	0.35	78.10	20.36
2	.05	.08	....	.11	78.51	20.96
3	.68	.16	Not det.	Not det.	78.08	20.14
4	.10	.70	....	....	79.26	19.40
5	.10	.10	....	....	78.55	20.94
6	.11	....	1.07	....	78.42	20.43
7	3.62	.45	4.09	.34	71.94	19.87
8	9.73	.78	4.32	Trace.	68.29	16.88

1. Gypsum from Blue Rapids, Kans.
2. Gypsum from Alabaster, Mich.
3. Gypsum from near Sandusky, Ohio.
4. Gypsum from Saltville, Va.
5. Gypsum from Hillsboro, New Brunswick.
6. Gypsum from Baddeck Bay, Nova Scotia.
7. Gypsite from Gypsum City, Kans.
8. Gypsite from Salina, Kans.

CHEMISTRY AND PRACTICE OF GYPSUM BURNING.

In addition to the combined water shown in the outline of composition, the rock may contain as much as 25 per cent of absorbed moisture. If pure gypsum is heated to a temperature of more than 212° F. and less than 400° F., all the moisture and a certain definite portion of the combined water will be driven off, and the gypsum thus partially dehydrated will be plaster of Paris. Plaster of Paris has the formula $CaSO_4.\frac{1}{2}H_2O$, corresponding to the composition:

$CaSO_4.\frac{1}{2}H_2O$	Lime sulphate ($CaSO_4$)	93.8
	Water (H_2O)	6.2

Three-fourths of the original combined water have therefore been driven off in the course of the process. Dehydration to this extent can, as above noted, be accomplished at any temperature between

[a] Eckel, E. C., Cements, limes, and plasters, Wiley & Sons, 1905, pp. 53–54.

212° F. and 400° F.; it is found, however, most economical of fuel and time to carry on the process at the highest allowable temperature.

A general plan of calcining plaster—the size and weight of machinery depending upon the capacity desired—is as follows:[a]

The gypsum rock is crushed first in a jaw crusher; second, in a pot crusher; and then it goes to a rotary kiln drier. This drier is erected in brickwork like a boiler, and is equipped with an automatic feeder. If soft coal or wood is used as fuel, care must be taken that the products of combustion do not come in contact with the materials being dried, on account of the danger of discoloration. Fuel of any kind—oil, gas, coke, wood, or coal—is suitable. This drying process eliminates 10 per cent of moisture. Next, the crushed rock is sieved in a trommel, generally to 24 mesh. The material that does not pass the sieve is ground in burr mills, and this product, with the screenings from the trommel, is ready for boiling. The boiling is done in a large kettle with wrought-steel sides and cast-iron or very heavy steel convex bottom. Flues pass through the kettle near the bottom and distribute the heat, which is applied below the kettle and passes around the lower part of the sides, through the flues, and then around the upper part of the sides and out at the stack. Inside the kettle is a shaft, which propels stirrers below the flues and mixing paddles above. The kettles are heavy and rest on brickwork. The ground gypsum is fed from bins into the kettle, and is constantly stirred and boiled until the remainder of the free moisture is expelled. The temperature of this preliminary boiling should not exceed 265° F., for at a higher temperature the water of crystallization, or combined water, begins to separate, and then the separation must be completed or the calcination will be a failure. To remove the necessary three-fourths of the combined water the material is then heated steadily to a temperature of 390° to 395° F. Care must be taken not to allow the temperature of this second boiling to exceed 400°, or all the combined water will be expelled and the plaster will lose its setting properties. When properly boiled the gypsum settles and may then be discharged through a gate on the side near the bottom of the kettle. After boiling, the plaster should be screened again through 40-mesh wire cloth, and the oversize should be reduced in a finishing burr mill.

GYPSUM PRODUCTS.

The bulk of the gypsum produced in the United States as well as in foreign countries is manufactured by grinding and partial or complete calcination into the various plasters, such as plaster of Paris, stucco, cement plaster, flooring plaster, hard-finish plaster, etc. A steadily increasing quantity is being used as a retarder in Portland cement. Refined grades of plaster are used in dental work, also as cement for plate glass during grinding, and as an ingredient in various patent cements. Considerable quantities are ground without burning and used as land plaster or fertilizer, while smaller quantities are used in the manufacture of paint, crayons, and paper, imitation meerschaum and ivory, and as an adulterant. The pure white massive form, known as alabaster, is much used by sculptors for interior ornamentation.

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[a] Bartlett, C. O., Manufacture of plaster of Paris: Eng. and Min. Jour., vol. 82, No. 23, Dec. 8, 1906 pp. 1063–1064.

For plaster of Paris and for dental, molding, and casting plasters a high grade of rock gypsum, ground very fine, is required, and the product is not mixed with any foreign substance or retarder, but is used in the pure or "neat" condition. Such plasters are quick setting and usually white in color. Much of the so-called cement plaster is made directly from gypsite, an impure unconsolidated earthy or sandy form of gypsum, which in many places is found to contain a suitable percentage of foreign material, so that the addition of a retarder is not necessary to effect a slow set. Where gypsite deposits are not available, cement plasters are made from rock gypsum by the addition of various mineral or organic retarders. A large part of the structural plaster now produced is used in specially prepared conditions that appeal to the builder on account of their convenience. A plaster board is pressed from plaster interlaminated with sheets of thin cardboard. This plaster board is furnished in thin sheets, 32 by 36 inches, comprising 8 square feet of surface, and is designed to be nailed directly to the studding in place of lath, and to receive a coat of wall plaster directly on its outer surface. Fibered plaster is molded into both solid and hollow blocks and tiles, which are used in partitions and interior construction, and these, as well as the plaster board, have been proved to be of value as fire retarders.

Wall plasters are of two general grades—one a brown or gray coat, and the other a white or tinted finish coat. The wall plasters are commonly made with wood fiber or hair filler, and a wood-pulp plaster is also being made that is finding use on the outside as well as on the inside of houses.

A number of hard-finish plasters are also made from gypsum, the most prominent representative of the group being Keenes cement, which was originally manufactured under English patents that have expired. The name "Keenes" is now applied by several manufacturers in the United States to their product, made by calcining very pure rock gypsum in lump form at a red heat and adding to the resulting dehydrated lime sulphate a substance like alum or borax. Keenes cement makes a very white and very hard plaster. It is used as a base for artificial marble and for ornamental castings, and its use as a wall plaster is increasing.

Gypsum is used in the manufacture of calcimines, in water paints and tints, and to a considerable extent as an ingredient in dry colors, notably in Venetian reds. When used in excess in mixed paints it is regarded as an adulterant. The unburned, or the dead-burned, forms of gypsum may be used to a certain extent with oil paints, because they are chemically inactive. The partially dehydrated form is not suitable for such use, but can be used with water.

To manufacture 100 tons of ordinary wall plaster a day the following machinery is necessary: (1) 1 crusher, estimated cost $1,000; (2) 1 direct-heat drier, 48 inches in diameter and 27 feet long, and 1 dust room, estimated cost $2,500; (3) 1 pot or bowl crusher for grinding the material after drying, estimated cost $300; (4) 4 French burrstones for fine grinding, cost about $300 each; (5) 2 calcining kettles, $200 each. In addition to this machinery, machines for mixing plasters besides the necessary elevators, conveyors, shafting, belting, and bins are required. On account of the nature of the process the elevators and conveyors should be made of steel, the bins of concrete or other noncombustible material, and the entire plant should be as nearly fireproof as possible.

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LITHIUM.

By Frank L. Hess.

SOURCES.

Lithium is one of the alkali metals and is the lightest known solid element. Its specific gravity (0.585) is so low that it will float on kerosene. Although traces of lithium are found in nearly all igneous rocks [a] and in many springs, and notable quantities of several lithium minerals occur in the United States at widely separated points, such minerals are not at all common.

In all places where lithium minerals visibly occur they are associated with granitic rocks and generally, if not always, with the latest phases of granitic intrusions, either in pegmatites or in granites and adjacent rocks which have been altered by hot gaseous emanations—a process known as pneumatolysis or pneumatolytic action. In some places large masses of lithium minerals which can be worked commercially are found in pegmatites, but in the altered granites only minor quantities of lithia mica are found. The places of occurrence of lithium are practically those of tin, but the large deposits of tin seldom contain workable deposits of lithium minerals. In the pegmatites, which may carry large quantities of lithium minerals, the tin deposits are generally small. Tourmaline, wolframite, columbite, beryl, and many other comparatively rare minerals are ordinarily associated with lithium minerals in pegmatites.

The most important lithium minerals are the following:

Lepidolite, a lithia mica, ordinarily containing from 4 to 5 per cent of lithia.

Triphylite and lithiophilite are phosphates of iron, manganese, and lithium, containing 8.15 to 9.36 per cent of lithia. As described by Dana,[b] the minerals grade from the bluish-gray triphylite with little manganese to salmon-pink or clove-brown lithiophilite with but little iron.

Spodumene, a silicate of aluminum and lithium, containing from 4.49 to 7.62 per cent of lithia.

Amblygonite, a fluophosphate of aluminum and lithium, containing ordinarily from 7.92 to 9.52 per cent of lithia.

There are a number of other lithium minerals but they are unimportant as a commercial source of lithia, because they either contain too small an amount of lithia or occur in deposits which are not large enough to be worked commercially.

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[a] Clarke, F. W., The data of geochemistry: Bull. U. S. Geol. Survey No. 330, 1908, p. 17.
[b] Dana, J. D., System of mineralogy, 6th ed., p. 756.

Lepidolite.—Lepidolite ranges in color through glistening white, yellowish, violet, and lilac tints. It occurs generally in small indistinct plates but in places forms six-sided crystals belonging to the monoclinic system. At Pala, Cal., and at other places it forms an outer rim around muscovite plates several inches across.

In the United States lepidolite is found in Hebron, Auburn, Norway, Paris, Rumford, and other places in western Maine; in South Dakota in considerable quantities in connection with the tin deposits of the southern Black Hills; and in great quantity with the beautiful red tourmaline, rubellite, in the neighborhood of Pala, San Diego County, Cal. At the Stewart mine, 2 miles northeast of Pala,[a] a mass of delicately tinted lilac-colored lepidolite showed a lenticular surface exposure 90 feet broad and 25 feet thick. In 1907 a drift at right angles to the exposure had been driven 125 feet in the lepidolite. Several hundred tons were mined and shipped from this deposit. Rubellite, also containing lithia, forms beautiful radial aggregates inclosed in the mass of lepidolite. Many thousand specimens obtained from this locality are distributed through the mineral collections of the world. After the spodumene and amblygonite deposits in the Black Hills of South Dakota were opened up it no longer paid to operate the Pala deposits. In the Black Hills lepidolite also was at one time worked to a small extent for its lithia content. At many other localities lepidolite is found in occasional flakes or small masses. At Wakefield, Canada, lepidolite occurs in plates several inches across.

Other lithium micas are cookeite, zinnwaldite, cryophyllite, polylithionite, and protolithionite. Zinnwaldite containing 3.36 per cent lithia was formerly worked at Zinnwald, Germany, for its lithium.[b]

Triphylite and lithiophilite.—Triphylite occurs in small amount at Peru, Me.;[c] Norwich, Mass.;[c] Grafton, N. H.;[c] and lithiophilite at Branchfield, Conn.,[c] and Tubb's farm, Me.[c] Minerals which probably belong to this group, but which are badly weathered or of which no analyses are known, occur in the tin-bearing pegmatite dikes of Kings Mountain, N. C., near Pala,[d] and in the Black Hills. In the Black Hills such a mineral occurs in many pegmatite dikes, probably in all which carry either lepidolite, spodumene, or amblygonite. The masses are very irregular in size and shape and are of a brownish or blackish color, in the latter case probably owing to the oxidation of some of the manganese. In places, both in South Dakota and in North Carolina, surfaces are coated with a fine purple film of purpurite, a decomposition product. In the Etta mine, South Dakota, masses of the mineral 3 to 4 inches in diameter have decomposed, leaving cavities partly filled with lilac, blue, and dark green vivianite, probably accompanied by another iron phosphate, dufrenite. In both the Etta and the Peerless mines a lithiophilite-like mineral occurs in sufficient abundance to yield a few tons annually in the course of mining for other minerals. As stated, it contains from 8.15 to 9.36 per cent of lithia, and if it occurred in large quantity would be equal to amblygonite as a lithia ore.

Probably both triphylite and lithiophilite occur in the Black Hills.

Alluaudite is a mineral closely related to lithiophilite, but of no commercial value.

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[a] Personal communication from W. T. Schaller, U. S. Geol. Survey.

[b] Singewald, Jos. T., jr., The Erzgebirge tin deposits: Econ. Geology, vol. 5, March, 1910, p. 173.

[c] Dana, op. cit.

[d] Personal communication from W. T. Schaller.

Spodumene.—Spodumene occurs in the same general localities mentioned for lepidolite, but is found in greatest quantity in the Black Hills. In the Etta mine, 1½ miles south of Keystone, the crystals of spodumene are immense, and so far as known are approached in size by no crystals found outside of the Black Hills. One crystal was 42 feet in length, with a cross section of approximately 3 by 6 feet. Part was decayed and useless, but about 37 tons of spodumene was mined from it.[a] At many places mining has exposed cross sections which are rectangles with truncated corners. Spodumene occurs—as do each of the other minerals mentioned—in pegmatite dikes. The dike at the Etta mine is oval in shape and about 150 by 200 feet in horizontal measurement. Tin was first discovered in the Black Hills in this mine, and previous to that the mine had been worked for mica. The Harney Peak Tin Mining, Milling, and Manufacturing Company put up a large mill near the property and made an unsuccessful effort to extract tin, but after a very short run ceased operations. Soon afterwards the company went into the hands of a receiver, and the mine lay idle for a number of years. Meanwhile, spodumene had attracted attention as a source of lithium, and the court allowed the receiver to lease the mine that it might be worked for this mineral. The crystals are considerably decayed, have an earthy appearance and the odor of a fresh clay pipe. Owing to the decay, the crystals have a fibrous, woody structure, and from this and their size the workmen ordinarily refer to them as "logs," which they much resemble. Cassiterite has been deposited along cracks in the spodumene and is evidently of later crystallization. For a number of years the deposit has been worked by the Standard Essence Company, of Maywood, N. J. It is an odd fact that amblygonite is almost wholly absent from this deposit, though in the Peerless claim half a mile away it occurs in large masses, with some spodumene.

Spodumene is found in many other dikes of the region; in some places, as on the Dewey claim, at the northwestern foot of Harney Peak, and on the Louise claim, 1 mile south of Oreville, it is fresh, glassy, and hard. On these latter claims the crystals are smaller, reaching only 2 or 3 feet in length and a few inches in breadth and thickness. An occurrence is reported from the vicinity of Custer, in which cross sections of crystals are exposed that rival those of the Etta mine. Although spodumene is found in crystals reaching a few inches in length at Pala and at several other places in the United States and in foreign countries, no other large deposits than those in the Black Hills are known.

Spodumene of an emerald-green color, when fresh enough to be glassy and clear, is known as hiddenite and sells for very high prices as a gem. As with most gems, the price is largely artificial. It is found at Hiddenite, N. C. A beautiful pink or lilac variety found near Pala and Rincon, San Diego County, Cal., is known as kunzite, and also sells at high prices. Some jewelers say that the stones lose their color, probably from strong light, and one jeweler showed the writer a stone which he said had faded in a comparatively short time. Kunzite when of a good clear color is one of the most beautiful of gem stones. In hiddenite and kunzite the refraction of light is high, so

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[a] Personal communication from A. M. Lane, Keystone, S. Dak.

that the stones have considerable brilliancy. Both varieties are reported from Madagascar.[a]

Beta-spodumene, cymatolite, and killinite are alteration minerals formed from spodumene, which have only mineralogical importance.

Petalite, castorite, and hydrocastorite are lithium minerals related to spodumene, but are without commercial value as a source of lithia.

Amblygonite.—Amblygonite is found in the same general localities that have been noted for lepidolite and spodumene. It contains a larger percentage of lithia than any mineral except lithiophilite, and, as it occurs in masses large enough to be easily and cheaply worked, it is more valuable, other conditions being equal, as a source of lithia than either of the other minerals. As found in South Dakota and California, it is a pearly white mineral with one good cleavage, and looks like a very fresh feldspar. In other places it has pale greenish, bluish, yellowish, or brownish tints. In 1907 and 1908 Mr. Herman Reinbold, of the Western Chemical Reduction Company, Omaha, Nebr., mined a large deposit of amblygonite of excellent quality on the Peerless claim, half a mile northeast of the Etta claim and 1 mile from Keystone, S. Dak. The shoot or mass of amblygonite was about 20 feet wide and had been excavated more than 20 feet in depth and 20 feet in length. This mass is said to have produced a total of 900 tons. Amblygonite in fair amount is found on the Tin Queen claim, 1½ miles east of Oreville, from which about 2 carloads were shipped by Mr. Reinbold several years ago. At present the company is mining amblygonite from a claim a short distance east of the Peerless, where the mineral, accompanied by spodumene, is said to occur in large amount. There is some amblygonite on the Ingersoll claim and probably on others in the vicinity. In the Pala locality a mass of amblygonite containing a few hundred tons was mined several years ago, but no other large mass has been found. Amblygonite has been mined at Montebras, central France, in a tin mine; at the San Finx tin mine, northwestern Spain; near Perig, Saxony; and in northern Australia. From the last-mentioned locality about 45 tons, valued at $1,000, were exported in 1906.

PRICES AND USES.

After the mining of amblygonite began on the Peerless claim at Keystone, S. Dak., the price of lithium carbonate fell from $2 or $2.50 per pound to 50 cents per pound, and large quantities have been sold at still lower prices.

The market for lithium minerals and salts has been a restricted one, as few uses have been known and the number of large consumers has been small. The product most manufactured is lithium carbonate, and for some time it was not widely known what use was made of the bulk of the product. Its use in the manufacture of artificial lithia waters and for medicinal purposes would account for only a few hundred pounds a year. It is now becoming generally known that it is mainly used in the manufacture of storage batteries. A small quantity probably also goes into the manufacture of fireworks.

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[a] Sterrett, Douglas B., Mineral Resources U. S. for 1907, U. S. Geol. Survey, vol. 2, 1908, p. 826.

Lithium (the metal) has no known practical use. It oxidizes very readily, is soft, not very tenacious, and is not known to have other properties that might make it economically valuable.

Of the lithium salts, lithium bromide is used in photography and in medicine, and various other salts are used for lithiasis (gravel), arthritis (inflammation of the joints), chronic rheumatism, and gout.

By many the use of natural lithium-bearing waters for various diseases is highly valued, especially in lithiasis, and a large trade is carried on in water from "lithia springs" in many parts of the United States. Concerning the medicinal use of lithium-bearing spring waters, Haywood and Smith[a] remark:

> While lithium seldom or never occurs in waters in large enough quantities to be a predominating basic constituent, still it does often appear in sufficient quantities to have a decided therapeutic action. These compounds are active diuretics and form a very soluble urate which is easily eliminated from the system. Waters of the above class therefore find their greatest application in the treatment of rheumatism, rheumatic tendencies, and gout. In cases of gravel and calculi they are also valuable disintegrating agents.

The same authors found that among the various lithia waters, that from the Carlsbad Spring of Saratoga carried the largest proportion of lithium, namely, 31.8 parts of lithium chloride per million. Some of the so-called lithia waters contain only extremely small quantities of lithia.

PRODUCTION.

In 1909 several carloads of amblygonite were shipped by the Western Reduction Company, of Omaha, Nebr., from its property near Keystone, S. Dak., and a few carloads of spodumene were shipped from the Etta claim by the Standard Essence Company to its works at Maywood, N. J. In view of the limited number of producers exact figures of production are not published.

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[a] Haywood, J. K., and Smith, B. H., Mineral waters of the United States: Bull. U. S. Dept. Agr., Bureau of Chemistry, No. 91, 1905, p. 12.

PHOSPHATE ROCK.

By F. B. Van Horn.

INTRODUCTION.

Owing to the fact that the collection of statistics of the production of phosphate rock in 1909 was carried on in cooperation with the Bureau of the Census the report is very much delayed in publication. On this account also it has been thought best to make the report purely statistical.

PRODUCTION.

The total production of phosphate rock in the United States in 1909 fell slightly below that for 1908. The output in 1909 was 2,330,152 long tons, valued at $10,772,120, as compared with 2,386,138 long tons, valued at $11,399,124, in 1908, a decrease in quantity of 55,986 tons, or 1.65 per cent, and in value of $627,004, or 5.5 per cent. This falling off was probably due in part to an overproduction of Florida hard rock in 1908 as well as to a long rainy season. The drop in price had its effect on the Tennessee rock, and many plants were shut down in that State. The average price per ton in 1909 was $4.62 as compared with $4.78 in 1908.

The following table shows the total production of phosphate rock in the United States from the beginning of the industry in 1867 to 1909.

Marketed production of phosphate rock in the United States, 1867–1909, in long tons.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
1867–1887	4,442,945	$23,697,019	1900	1,491,216	$5,359,248
1888	448,567	2,018,552	1901	1,483,723	5,316,403
1889	550,245	2,937,776	1902	1,490,314	4,693,444
1890	510,499	3,213,795	1903	1,581,576	5,319,294
1891	587,988	3,651,150	1904	1,874,428	6,580,875
1892	681,571	3,296,227	1905	1,947,190	6,763,403
1893	941,368	4,136,070	1906	2,080,957	8,579,437
1894	996,949	3,479,547	1907	2,265,343	10,653,558
1895	1,038,551	3,606,094	1908	2,386,138	11,399,124
1896	930,779	2,803,372	1909	2,330,152	10,772,120
1897	1,039,345	2,673,202			
1898	1,308,885	3,453,460	Total	33,924,431	139,487,246
1899	1,515,702	5,084,076			

The production of the different classes of phosphate rock, by States, in 1908 and 1909 was as follows:

Production of phosphate rock in the United States, 1908–1909, based on the quantity marketed.

State.	1908.			1909.		
	Quantity (long tons).	Value.	Average price per ton.	Quantity (long tons).	Value.	Average price per ton.
Florida:						
Hard rock	595,743	$4,566,018	$7.66	513,585	$4,026,333	$7.84
Land pebble	1,085,199	3,885,041	3.58	1,266,117	4,514,968	3.56
River pebble	11,160	33,480	3.00	0	0	....
Total	1,692,102	8,484,539	5.01	1,779,702	8,541,301	4.79
South Carolina:						
Land rock	192,263	854,837	4.45	201,254	888,611	4.41
River rock	33,232	135,044	4.06	6,700	21,975	3.28
Total	225,495	989,881	4.39	207,954	910,586	4.37
Tennessee						
Brown rock	374,114	1,572,525	4.20	266,298	1,011,028	3.79
Blue rock	79,717	299,941	3.76	66,705	275,165	4.12
White rock	1,600	4,755	2.97	0	0	....
Total	455,431	1,877,221	4.12	333,003	1,286,193	3.86
Other States[a]	13,110	47,483	3.62	9,493	34,040	3.58
Grand total	2,386,138	11,399,124	4.78	2,330,152	10,772,120	4.62

[a] Includes Arkansas, Idaho, Utah, and Wyoming.

The figures in the foregoing table are based on the marketed product. The actual production from Florida during 1909 was 1,890,968 long tons; in South Carolina it was 199,714 long tons; in Tennessee it was 343,650 long tons; and in Arkansas, Idaho, Utah, and Wyoming it was 10,105 long tons—a total of 2,444,437 long tons.

PRODUCTION BY STATES.

FLORIDA.

As usual, the production from Florida showed an increase in 1909 over that in 1908, the total production being 1,779,702 long tons, or 87,600 tons more than in 1908, an increase of 5.1 per cent. The output of hard rock decreased 82,158 tons; that of land pebble increased 180,918 tons; and that of river pebble fell away to nothing. The total value, $8,541,301, showed an increase of $56,762. The price of hard rock in 1909 was $7.84, as compared with $7.66 in 1908; and that of land pebble was $3.56 in 1909, as compared with $3.58 in 1908. The average price was $4.79 in 1909, as compared with $5.01 in 1908, a loss of 4.4 per cent. In 1909 Florida furnished 76.3 per cent of the entire production of the United States.

The quantity and value of each variety of phosphate rock produced in Florida from 1905 to 1909, inclusive, based upon reports of marketed materials, are shown in the following table:

Phosphate rock marketed in Florida, 1905–1909, classified by grades, in long tons.

Year.	Hard rock.		Land pebble.		River pebble.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1905	577,672	$2,993,732	528,587	$1,045,113	87,847	$213,000	1,194,106	$4,251,845
1906	587,598	3,440,276	675,444	2,029,202	41,463	116,100	1,304,505	5,585,578
1907	646,156	4,065.375	675,024	2,376,261	36,185	136,121	1,357,365	6,577,757
1908	595,743	4,566,018	1,085,199	3,885,041	11,160	33,480	1,692,102	8,484,539
1909	513,585	4,026,333	1,266,117	4,514,968	....	....	1,779,702	8,541,301

SOUTH CAROLINA.

The production of phosphate rock from South Carolina in 1909 showed a decrease from that in 1908 of 17,541 long tons, or 7.7 per cent. The production in 1909 was 207,954 tons, valued at $910,586; in 1908 it was 225,495 tons, valued at $989,881. The land rock production increased from 192,263 long tons in 1908 to 201,254 tons in 1909, a gain of 8,991 tons, but the output of river rock fell off from 33,232 tons in 1908 to 6,700 tons in 1909, a loss of 26,532 tons. The price per ton of land rock was $4.41 in 1909, as compared with $4.45 in 1908; that of river rock was $3.28 in 1909, as compared with $4.06 in 1908. The average price per ton of all South Carolina rock was $4.37 in 1909, as against $4.39 in 1908. South Carolina produced 8.9 per cent of the phosphate rock mined in the United States in 1909.

The quantity and value of each variety of South Carolina rock marketed from 1905 to 1909, inclusive, are shown in the following table:

Phosphate rock marketed in South Carolina, 1905–1909, classified by grades, in long tons.

Year.	Land rock.		River rock.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1905	234,676	$774,447	35,549	$103,722	270,225	$878,169
1906	190,180	711,447	33,495	105,621	223,675	817,068
1907	228,354	883,965	28,867	96,902	257,221	980,867
1908	192,263	854,837	33,232	135,044	225,495	989,881
1909	201,254	888,611	6,700	21,975	207,954	910,586

TENNESSEE.

The year 1909 showed a very great reduction in the production of phosphate rock in Tennessee from that of 1908. The total output was 333,003 long tons, valued at $1,286,193. This was a loss of 122,428 tons, or 26.8 per cent, in quantity and of $591,028, or 31.5 per cent, in value from 1908, when the production was 455,431 long tons, valued at $1,877,221. The value of brown rock in 1909 as compared with 1908 decreased from $4.20 to $3.79; the value of blue rock increased from $3.76 to $4.12; and there was no production of white rock reported. The average price per ton of all rock decreased from $4.12 in 1908 to $3.68 in 1909, a loss of 6.3 per cent. Tennessee furnished 14.3 per cent of the entire production in the United States in 1909.

The following table shows the tonnage and value of each grade of Tennessee phosphate marketed from 1905 to 1909, inclusive:

Phosphate rock marketed in Tennessee, 1905–1909, classified by grades, in long tons.

Year.	Brown rock.		Blue rock.		White rock.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1905	438,139	$1,509,748	44,031	$121,486	689	$2,155	482,859	$1,633,389
1906	510,705	2,027,917	35,669	114,997	1,303	5,077	547,677	2,147,991
1907	594,594	2,880,904	38,993	142,382	5,025	24,550	638,612	3,047,836
1908	374,114	1,572,525	79,717	299,941	1,600	4,755	455,431	1,877,221
1909	266,298	1,011,028	66,705	275,165	....	....	333,003	1,286,193

OTHER STATES.

Arkansas, Idaho, Utah, and Wyoming were the only other States to produce phosphate rock in 1909. The total production from these States was 9,493 tons in 1909, as compared with 13,111 tons in 1908—a loss of 3,618 tons. The production from these States was about one-half of 1 per cent of the total production in the United States for the year.

IMPORTS.

The following table shows the imports of fertilizers[a] into the United States for the years 1905 to 1909, inclusive:

Fertilizers imported and entered for consumption in the United States, 1905–1909, in long tons.

Year.	Guano.		Kieserite and kainite.		Apatite, bone dust, crude phosphates, and other substances used only for manure.		Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
1905	27,104	$379,667	351,053	$1,850,622	197,115	$2,450,835	$4,681,124
1906	23,222	322,766	334,843	1,790,969	211,274	2,598,451	4,712,186
1907	30,287	400,054	346,266	2,526,584	194,121	2,579,843	5,506,481
1908	5,728	92,659	129,063	730,934	96,091	1,153,002	1,976,595
1909	44,197	772,674	166,692	861,894	281,345	4,336,225	5,970,793

[a] "Fertilizers" as here used include the articles given in the table which are grouped by the Bureau of Statistics as free of duty under the tariff law; it does not include the potassium and sodium compounds imported as fertilizers.

EXPORTS.

During 1909 there were exported 1,020,556 long tons of phosphate rock, having a value of $7,644,368.

WORLD'S PRODUCTION.

The world's production of phosphate rock for the years 1906 to 1908, inclusive, was as follows:

World's production of phosphate rock, 1905–1907, by countries, in metric tons.

Country.	1906.		1907.		1908.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Algeria	333,531	$965,600	373,763	$2,183,404	452,060	$2,639,940
Aruba (Dutch West Indies)	26,138	(a)	36,036	(a)	29,061	(a)
Belgium	152,140	282,612	182,230	332,114	198,030	355,897
Canada	521	4,024	748	6,018	1,448	14,794
Christmas Island (Straits Settlements)	92,010	(a)	112,147	(a)	110,849	(a)
France	469,408	1,872,000	431,237	1,876,736	485,607	1,896,606
Norway	3,482	46,524	(b)	....	....	....
Spain	1,300	7,592	(b)	....	....	....
Tunis	796,000	2,304,400	1,069,000	4,547,842	1,300,543	5,531,624
United Kingdom	....	....	33	224	9	68
United States	2,114,252	8,579,437	2,301,588	10,653,558	2,424,453	11,399,124

a Value not reported. b Statistics not yet available.

SALT AND BROMINE.

By W. C. Phalen.

SALT.

PRODUCTION.

Common salt occurs as rock salt, in sea water, and in brine, derived from springs, lakes, or wells. It is found also stored in various beds in the crust of the earth. It is obtained from all these sources in the United States.

In 1909 the quantity of salt produced in this country amounted to 30,107,646 barrels of 280 pounds each, valued at $8,343,831; in 1908 the production reported was 28,822,062 barrels, valued at $7,553,632, an increase in the output for 1909 of 1,285,584 barrels in quantity and of $790,199 in value. Expressed on a tonnage basis these quantities represent an output of 4,035,089 short tons in 1908 and of 4,215,070 short tons in 1909, an increase in the latter year of 179,981 tons.

In 1908 the average net value was 26.208 cents per barrel or $1.87 per short ton; in 1909 the average net value was 27.713 cents per barrel or $1.98 per short ton, an increase in 1909 of 1.505 cents per barrel, or 11 cents per ton. Though the increases appear small, they are notable advances over the corresponding figures for 1908.

The following table shows the quantity and value of salt reported as produced in the United States from 1893 to 1909:

Production and value of salt in the United States, 1893–1909.

1893..barrels..	11,897,208	$4,154,668	1902..barrels..	23,849,231	$5,668,636
1894....do....	12,968,417	4,739,285	1903....do....	18,968,089	5,286,988
1895....do....	13,669,649	4,423,084	1904....do....	22,030,002	6,021,222
1896....do....	13,850,726	4,040,839	1905....do....	25,966,122	6,095,922
1897....do....	15,973,202	4,920,020	1906....do....	28,172,380	6,658,350
1898....do....	17,612,634	6,212,554	1907....do....	29,704,128	7,608,323
1899....do....	19,708,614	6,867,467	1908....do....	28,822,062	7,553,632
1900....do....	20,869,342	6,944,603	1909....do....	[a] 30,107,646	[a] 8,343,831
1901....do....	20,566,661	6,617,449			

[a] Includes production of Hawaii and Porto Rico.

PRODUCTION OF SALT BY GRADES AND STATES.

Production by grades.—Salt is largely used for culinary purposes, and also in the meat-packing, fish-curing, dairying, and other industries to preserve the products from deterioration. The chlorination of gold also consumes large quantities of salt. In the form of brine it is largely used in the chemical industries in the preparation of soda ash (sodium carbonate), caustic soda, and various other chemicals containing a sodium base.

For convenience salt is classified according to the grades by which it is sold by the producer, the grades being determined by the amount of refining, the methods employed in refining, and the purposes for which the salt is used. These grades are "table and dairy," "common fine," "common coarse," "packers," "solar," "rock," "milling," "brine," and "other grades." The "table and dairy" salt includes extra fine and fancy grades prepared for family use, and all grades artificially dried, used for butter and cheese making, and such special brands. Under "common fine" salt are included all other grades of fine salt of first quality, not artificially dried, such as those known to the trade as "C. F.," "No. 1 F," "anthracite," etc. "Common coarse" salt includes all grades coarser than "common fine," made by artificial heat, such as "steam coarse," "No. 1 coarse," "pan solar," "G. A.," "Liverpool ground," "C. C.," etc. By "packers" salt is meant those grades prepared for the purpose of curing fish, meats, etc. "Coarse solar" includes all coarse salt made by solar evaporation. "Rock" salt includes all salt mined and shipped without special preparation. "Mill" salt is that used in gold and silver mills, and "other grades" includes all low-grade or No. 2 salt, used in salting cattle and for fertilizers, track purposes, etc. "Brine" includes all salt liquor used in the manufacture of soda ash, sodium bicarbonate, sodium hydrate (caustic soda), and other sodium salts or brine sold without being evaporated to dryness.

The following table shows the salt production of the United States by grades during the last five years:

Production of salt, by grades, in the United States, 1905–1909, in barrels.

Year.	Table and dairy.	Common fine.	Common coarse.	Packers.	Solar.
1905	2,380,808	6,818,690	2,724,769	327,192	903,143
1906	2,923,044	6,483,937	2,550,209	452,490	1,080,591
1907	3,537,157	7,684,638	2,055,054	422,324	862,929
1908	3,202,016	7,388,903	2,550,333	373,284	1,156,034
1909	3,042,824	7,745,204	2,843,393	385,802	1,283,548

Year.	Rock.	Other grades.	Brine.	Total production.	Total value.
1905	4,733,765	207,824	7,869,931	25,966,122	$6,095,922
1906	4,873,526	234,903	9,573,680	28,172,380	6,658,350
1907	5,809,328	110,227	9,222,471	29,704,128	7,439,551
1908	5,161,211	121,065	8,869,216	28,822,062	7,553,632
1909	5,938,721	97,347	8,770,807	30,107,646	8,343,831

Production by States.—The following table gives the production and value of the salt produced in the United States from 1906 to 1909, inclusive, by States:

Production and value of salt, 1906–1909, by States, in barrels.

State.	1906.		1907.		1908.		1909.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
New York	8,978,630	$2,098,686	9,642,178	$2,335,150	a10,023,872	a$2,386,471	a10,914,255	a$2,646,736
Michigan	9,936,802	2,018,760	10,7[illegible]6,630	2,062,357	10,194,279	2,458,303	9,966,744	2,732,556
Ohio	3,236,785	789,237	3,851,243	979,078	3,427,478	864,710	3,684,775	993,700
Kansas	2,198,837	681,022	2,667,459	962,334	2,588,814	882,984	2,769,849	782,676
Louisiana	1,179,528	268,005	1,157,621	226,892	(b)	(b)	(b)	(b)
California	806,788	291,528	626,693	302,940	899,028	374,828	886,564	558,889
West Virginia	200,055	57,584	156,147	76,527	145,157	70,481	150,492	76,463
Texas	360,733	170,559	356,086	226,540	412,571	255,652	409,315	260,286
Utah	262,212	169,635	345,557	199,779	242,678	169,833	246,935	147,318
Hawaii	....	....	....	....	....	....	7,796	5,292
Idaho	1,574	1,867	1,600	2,040	1,114	1,413	793	1,118
Porto Rico	....	....	....	....	....	....	166,790	26,810
Nevada	11,249	6,420	6,457	3,654	9,714	4,785	16,107	19,847
Oklahoma	9,893	4,965	800	910	(c)	(c)	(c)	(c)
Other States	d 989,294	100,082	e 105,657	61,350	f 847,357	84,172	f 887,231	92,140
Total	28,172,380	6,658,350	29,704,128	7,439,551	28,822,062	7,553,632	30,107,646	8,343,831

a Includes Louisiana.
b Included in New York.
c Included in "Other States."
d Includes Virginia, Pennsylvania, New Mexico, and Massachusetts.
e Includes Pennsylvania, New Mexico, and Massachusetts.
f Includes New Mexico, Oklahoma, Pennsylvania, and Virginia.

During and since 1905 Michigan has produced a larger quantity of salt than New York; but until 1908 the average net price per barrel has been so much less in the former State than in the latter that the difference in the production has not compensated for the difference in price per barrel. During 1908 and 1909 the value of the Michigan product has been greater than that of New York. The six leading States in the salt industry, namely, Michigan, New York, Ohio, Kansas, Louisiana, and California, maintained the same relative rank in 1909 as in 1908. The order of rank based on value of output was not the same as that given above. The value of the salt produced in California exceeded that of either Texas or Louisiana, and the Texas product was valued at a greater figure than that of Louisiana.

Production by States and grades.—The following table shows the grades of salt produced in the different States. Brine and "Other grades" are combined in order to conceal the individual production of dry salt obtained from the brine.

The production of salt in 1909, by States and grades, in barrels.

State.	Table and dairy.		Common fine.		Common coarse.		Packers.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
California	180,214	$194,307	82,843	$94,342	7,236	$6,096	156,200	$71,996
Idaho	....	....	328	568	36	60	....	....
Kansas	66,690	99,094	1,154,849	335,287	207,357	83,750	....	....
Michigan	585,370	732,907	3,530,303	1,125,095	2,103,719	647,878	93,357	39,833
Nevada	450	938	1,429	4,000	....	....	....	....
New York	1,277,440	662,226	1,447,899	524,715	184,197	69,887	60,276	23,321
Ohio	803,629	419,654	997,628	364,288	300,293	99,250	74,541	34,194
Texas	78,075	70,034	292,658	162,628	6,697	5,899	....	....
Utah	43,836	54,183	12,579	12,141	21,428	8,000	1,428	400
West Virginia	6,213	6,000	144,279	70,463	....	....	....	....
Other States	907	785	80,409	43,390	12.430	8,291	....	....
Total	3,042,824	2,240,128	7,745,204	2,736,917	2,843,393	929,111	385,802	169,744

State.	Coarse solar.		Rock.		Other grades and brine.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
California	432,779	$175,142	24,171	$13,238	3,121	$3,768	886,564	$558,889
Hawaii	7,362	4,988	....	....	434	304	7,796	5,292
Idaho	286	380	143	110	....	....	793	1,118
Kansas	....	....	1,336,353	263,257	4,600	1,288	2,769,849	782,676
Louisiana	....	....	(a)	(a)	....	....	(a)	(a)
Michigan	....	....	5,600	1,792	3,648,395	185,051	9,966,744	2,732,556
Nevada	14,228	14,909	....	....	....	....	16,107	19,847
New Mexico	....	....	....	....	....	....	(b)	(b)
New York	504,897	208,168	c 4,535,804	c 995,645	2,903,742	162,774	c 10,914,255	c 2,646,736
Ohio	....	....	....	....	1,508,684	76,314	3,684,775	993,700
Oklahoma	....	....	....	....	....	....	(b)	(b)
Pennsylvania	....	....	....	....	....	....	(b)	(b)
Porto Rico	166,790	26,810	....	....	....	....	166,790	26,810
Texas	27,635	19,345	....	....	4,250	2,380	409,315	260,286
Utah	129,571	58,356	36,650	13,925	1,443	313	246,935	147,318
Virginia	....	....	....	....	....	....	(b)	(b)
West Virginia	....	....	....	....	....	....	150,492	76,463
Other States d	....	....	....	....	793,485	39.674	887,231	92,140
Total	1,283,548	508,098	5,938,721	1,287,967	8,868,154	471,866	30,107,646	8,343,831

a Included in New York.
b Included in "Other States."
c Includes Louisiana.
d Includes New Mexico, Oklahoma, Pennsylvania, and Virginia.

THE SALT INDUSTRY BY STATES

Salt was produced on a commercial scale in 1909 in 14 States and 1 Territory, as follows: California, Idaho, Kansas, Louisiana, Michigan, Nevada, New Mexico, New York, Ohio, Oklahoma, Pennsylvania, Texas, Utah, Virginia, and West Virginia. Returns were also received from Hawaii and Porto Rico. Brief descriptions of the salt industry in some of these States follow:

CALIFORNIA.

In the quantity of salt produced, California ranked sixth among the States in 1909, maintaining the same relative position as in the two preceding years. In the value of output it ranked fifth during 1907, 1908, and 1909. The output of the State in 1909 was 886,564 barrels, or 124,119 short tons, valued at $558,889, an average of 63 cents per barrel or $4.50 per ton, as compared with 42 cents per barrel or

$2.98 per ton in 1908. Practically all the salt produced in California came from Alameda, Los Angeles, Modoc, San Bernardino, San Diego, and San Mateo counties. By far the greater part of this salt is obtained by solar evaporation, but steam or direct application of heat are methods also used at some of the plants. Owing to weather conditions, the production at some of the coast plants was less per acre than during ordinary years. This result was caused by floods during the winter of 1908–9, which not only reduced the stock of pickle on hand, but also washed away considerable salt.

IDAHO.

The production in Idaho in 1909 was 793 barrels of salt, valued at $1,118, as compared with 1,114 barrels, valued at $1,413 in 1908. The salt was produced entirely in Bannock County, in the southeast corner of the State near the Wyoming line. The headquarters of most of the operators are in Wyoming, at Afton and Auburn. An account of the salt resources of the Idaho-Wyoming border with notes on their geologic occurrence has been published in a recent bulletin of the Survey by C. L. Breger, from whose article the following statements are quoted:[a]

Valuable areas of salt-bearing land lie along the Wyoming-Idaho border in Bannock County, Idaho, and the middle-western part of Uinta County, Wyo. The deposits occur west of the Salt River valley, or Star Valley, as it is locally known. In the old days, before the advent of railroads in the West, relatively large amounts of salt were boiled from the brine springs in this region and were hauled by ox team to supply Idaho and Montana mining camps. The emigrants to the Northwest along the Lander route also drew upon this region for their salt. * * *

Interest in these salt deposits has recently been revived, owing to the discovery of rock salt beneath the brine springs in lower Crow Creek. James Splawn and H. Hokanson, in deepening these springs in 1902, encountered a formation of rock salt 6 feet below the surface and this has been penetrated for a thickness of 20 feet without reaching the bottom. The exceptional purity of the salt, its cheapness of production, and the probability of railroad connections in the near future lend interest to the deposits of the entire district.

LOCATION.

The only rock salt encountered in the region to date occurs on the southeast side of the Crow Creek valley, along the route from Montpelier, Idaho, to Star Valley. The locality is opposite the Lowe ranch, 38 miles northeast of Montpelier, and 12 miles southwest of Afton, Wyo. The property is owned by John W. Booth, of Afton, who also owns a brine spring in upper Crow Creek, 6 miles nearer Montpelier. The latter has not been worked in recent years.

The principal operating brine springs are located on Stump Creek and in Tygee Valley, which are west of Star Valley, on the Idaho side of the state line. Most of the springs are near the junction of Stump and Tygee creeks. The Petersen spring, now owned and operated by Soren Petersen, of Auburn, is located on Tygee Creek, about half a mile southwest of the junction. The McGrew spring, owned and operated by John C. McGrew, of Stump Creek, is located on Stump Creek about half a mile northwest of the junction; and a mile farther north, up Stump Creek, are the Reed springs, owned and operated by Sydney Reed, of Auburn. Still farther up Stump Creek, about 5 miles above the Reed springs, occur the old Stump and White springs. These have not been operated in recent years. To the south, up Tygee Creek, the next worked spring is the Draney, 4 miles south of the Petersen spring.

Another salt-producing area is situated on the Wyoming side of the boundary line, south of Star Valley, on the route from Smoot and the upper end of Star Valley to Thomas Fork. This locality is on Salt Creek and is reported to be 7 or 8 miles northeast of Green's ranch, or the head of Thomas Fork. The plats of the General Land Office show it in the SW. ¼ sec. 26, T. 29 N., R. 119 W., east of the middle of the quarter. This brine spring was not visited.

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[a] Bull. U. S. Geol. Survey No. 430, 1910, pp. 555–569.

MODE OF OCCURRENCE.

The productive brine springs have no immediate relation to the solid rock formations occurring near by. The springs occur in the valley bottoms in barren patches of stony clay or gravel, which are rendered soggy by the contained brine. These salty places may be recognized at a distance by their gray color; in some of them a little salt incrusts the barren surface. Near by are terraces of reddish clays which will be described in connection with the geology.

A brine spring is made by digging a hole about 3 feet deep, 2 to 4 feet wide, and 3 or 4 feet long. This soon fills with water so saturated with salt that it frequently has a sirupy consistency or appearance when dipped up.

CHEMICAL COMPOSITION AND QUALITY.

Analyses of the rock salt of the district, made by Chase Palmer at the United States Geological Survey chemical laboratories, show:

Composition of rock salt of Idaho-Wyoming district.

Soluble ("salt")	91.79
Insoluble [a]	6.42
Moisture	.85
	99.06

According to Dr. Palmer's figures, the "salt" of the above analysis shows the following composition:

Analysis of "salt" from Idaho-Wyoming district.

Sodium chloride (NaCl)	98.900
Calcium sulphate ($CaSO_4$)	.817
Potassium chloride (KCl)	.261
Magnesium chloride ($MgCl_2$)	.022
	100.000

The rock salt is stained a reddish-brown color owing to the presenceof clay containing ferric oxide. When the rock salt is dissolved in water and evaporated, the iron oxide disappears, leaving a brilliant pure-white product. This pure-white salt may be observed incrusting the ground near the water-filled shafts in the rock salt and along the ditches which are used to drain the shafts of water. Samples of this natural sun-dried white salt from the shafts and ditches, which probably represent more nearly average conditions for the entire body of rock salt, conform with the sample of raw rock salt analyzed in showing over 98 per cent of pure salt or sodium chloride, with practically negligible amounts of potassium and magnesium. The white salt has a slightly higher content of lime sulphate—1.48 per cent as compared with 0.817 per cent in the sample of raw rock salt analyzed.

A partial analysis of commercial table salt boiled from one of the Stump Creek brine springs was also made by Dr. Palmer. This analysis probably represents the usual quality of the salt boiled from the various brine springs of the Tygee-Stump Creek region. The analysis shows only a trace of magnesium and 0.73 per cent of lime (CaO), equivalent to 1.77 per cent of calcium sulphate ($CaSO_4$). The salt is thus similar chemically to the Crow Creek rock salt in the low or almost negligible magnesium content and the high percentage of pure salt or sodium chloride.

A comparison of the Idaho-Wyoming salts with other salts of the United States is indicated in the table following.[b]

[a] Composed as follows:

Red clay	SiO_2	4.36
	Fe_2O_3	.27
	Al_2O_3	.88
	MnO	Trace.
Lime and magnesium sulphates and carbonates	MgO	.13
	CaO	.67
	SO_3	.11
	CO_2	Not determined.

[b] After Harris, G. D., Rock salt, its origin, geological occurrences, and economic importance in the State of Louisiana together with brief notes and references to all known salt deposits and industries of the world: Geol. Survey Louisiana, Bull. No. 7, 1908.

Composition of various rock salts and brines.

Soluble portions of rock salt.

	Sodium chloride (NaCl).	Calcium sulphate ($CaSO_4$).	Magnesium chloride ($MgCl_2$).	Calcium chloride ($CaCl_2$).
Crow Creek, Bannock County, Idaho	98.9	0.82	0.022	....
Retsof, N. Y	98.7	.484	.055	....
Pearl Creek, N. Y	96.9	.437	.103	....
Petite Anse, La	99.1	.330	....	....
Belle Isle, La	96.4	3.051	.74	....
Saltville, Va	99.1	.448	....	....
Do	93.05	2.400	....	....

Brines.

	Sodium chloride (NaCl).	Calcium sulphate ($CaSO_4$).	Magnesium chloride ($MgCl_2$).	Calcium chloride ($CaCl_2$).
Crow Creek, Bannock County, Idaho	98+	1.48	0.022	....
Stump Creek, Bannock County, Idaho	98+	1.77	Trace.	....
Pearl Creek, N. Y	97.48	1.68	.55	0.26
Syracuse, N. Y	95.33	2.30	.85	1.52
Bay City, Mich	91.95	2.39	2.48	3.19
Kanawha, W. Va	79.45	....	4.07	16.48
Pittsburg, Pa	81.27	....	4.80	13.93
Colorado City, Tex	95.86	1.63	1.46	.173
Salt Lake, Utah (refined brine, or commercial salt)	98.3	.68	....	.345

The above table shows that the Idaho salts are above the average in quality and compare favorably with some of the best salt produced. It may be stated that the chemical quality of salt is determined by (1) the amount of pure salt, or sodium chloride, in it and (2) the amount of impurities it contains. The impurities comprise (1) material which is usually neither harmful nor beneficial and consists chiefly of lime carbonate, gypsum, calcium chloride, clayey matter, etc., and (2) material which may be harmful, as magnesium chloride and calcium sulphate, which cause the finer grades of salt to "cake" or take up moisture, or soluble iron and iodine, which are usually considered physiologically injurious.

As to the physical quality of the salt, a brilliant pure-white product can be obtained from these deposits, as is shown by the incrustations about the shaft and ditches in the Crow Creek rock-salt deposit, and as may frequently be observed in the Stump-Tygee boiled or commerical salts, when these have been handled at all carefully. Commonly, however, the salt is boiled in smoke and cinder filled log cabins, where little or no precautions as to cleanliness are taken. The result has been that much of the salt lacks the brilliancy of whiteness requisite for the finer or table grades. However, as the Idaho salt has been boiled largely for sheep and stock use, cleanliness has not been so imperative in its production. Brilliant pure-white salt has been and can be obtained from the brines when treated with merely ordinary care.

TREATMENT.

Present methods.—The equipment and methods of treatment in this region have been and are now very crude. The brine is dipped up in pails by hand and poured into sheet-iron shovel-shaped troughs or pans, which are about 10 feet long, 3 or 4 feet wide, and 10 inches deep. Each pan rests on a three-sided fire box, about 3 feet high, built of rough field stone held together with clay. The front of the box is left open for firing. The salt or brine is stirred with a shovel as the water boils off, and a common to medium fine grade product is the result. There is no equipment for milling or grinding. The pans and fire boxes, two or three in number, are inclosed in a log cabin. It is locally reported that boiling takes place more rapidly under cover than out of doors. As to fuel, there are no extensive forests in this locality, nor indeed any forests at all worthy of the name; but timber patches and windfallen logs in the mountains west of Tygee and Stump creeks furnish ample fuel for present needs. The hauling of fuel appears to be the most laborious and costly item. With railroad connections, cheap coal could be obtained from the Evanston, Kemmerer, and southwestern Wyoming fields or from possible coal fields in the Snake River canyon country, about 35 miles north of the salt district.

Possibilities of solar evaporation.—The abundance of sunshine and the dryness of the atmosphere in this region are very favorable conditions for the cheaper and cleaner process of solar evaporation in place of the more rapid boiling process which has heretofore been used. Should this process be attempted, however, the methods in use about Salt Lake and San Francisco, where brine is allowed to overflow extensive diked flats and evaporate, would be impracticable here, owing to the nature of the topography. The brine would have to be carried to evaporating pans, but in several places this could be done by gravity, the brine being piped directly from the spring, without pumping. The use of raised storage tanks, however, would be desirable. With a faucet supplying each pan and an automatic drip or flow of the brine from the faucet at nearly the rate of exaporation in the pan, the items of fuel and labor would be reduced to a minimum of expenditure, and the resulting salt would have a maximum of cleanliness.

Treatment of rock salt.—The rock salt on Crow Creek has been blasted out with dynamite in two surface pits or shafts about 20 feet square. One of these shafts is reported to have penetrated 20 feet of rock salt without reaching the bottom and to show at that depth cleaner salt than at the surface. Both shafts were filled with water at the time of the writer's visit. The water is drawn off prior to working by means of barrels and a crane, horses furnishing the power. The rock salt is sold in large, rough chunks or is hammered into finer fragments and sacked.

MARKET AND PRICES.

The salt of this district supplies the sheep herders and stockmen of eastern Idaho and middle western Wyoming. The raw, broken rock salt is now supplanting the boiled white salt for stock use on account of its cheapness. The finer grades of white salt are consumed for table use locally in Star Valley and vicinity, and a little finds its way now and then to Montpelier. In 1908 the rock salt of Crow Creek sold for 50 cents per 100 pounds sacked, or 40 cents in bulk. In 1909 the price of the rock salt was reduced to 40 cents sacked and 30 cents in bulk. The white or boiled salt of Tygee and Stump creeks sells for 75 cents per 100-pound sack for the finer or table and dairy grades and 50 cents for the coarser or stock grades.

ACCESSIBILITY.

Haulage to the nearest railroad station, Montpelier, Idaho, on the Oregon Short Line, costs at present 50 to 80 cents per 100 pounds, so that under existing conditions outside markets are out of the question. With a railroad in the Star Valley, however, the salt of this district would command the markets of western Montana, northern and western Wyoming, and northern and eastern Idaho. The Burlington, Union Pacific, Oregon Short Line, and independent railroad interests have surveyed routes that pass through Star Valley. Just now there are persistent rumors of construction by the Burlington in the very near future. There can be no question that in time the country will have railroad communication, for not only is the valley one of the richest and most progressive farming and grazing districts of the Wyoming-Idaho border country, but there is an abundance of minable phosphate rock, beautiful building stone, Portland cement, and lime, in the mountains both east and west of Star Valley and Crow Creek, in addition to the salt deposits. All these resources might be profitably developed with railroad connections.

Star Valley furnishes the easiest route to upper Snake River, Pacific Creek, Two Ocean Pass, and the Yellowstone. Such a railroad would probably reach the valley via Crow Creek from the Oregon Short Line at Montpelier, Idaho, and would pass the Crow Creek salt deposits. A spur from Star Valley to the phosphate deposits in the mountains on the west would pass through Stump Canyon and tap the salt deposits in Stump and Tygee creeks. There has also been some talk of running a spur southward into Star Valley from a projected trunk line extending up Snake River from a point near Idaho Falls, instead of from Montpelier. * * *

ESTIMATED EXTENT OF SALT DEPOSITS.

Probability of rock salt underlying the springs.—Solid salt deposits of some kind apparently underlie all the productive brine-spring areas. This is borne out by (1) the saturated character of the brines, (2) the similarity of geologic conditions in the single rock-salt area positively known to contain rock salt and in all the brine-spring areas, and (3) the fact that this rock-salt area itself was originally a brine-spring area similar to those of the present brine springs. Rock salt has been reported under the Petersen spring, in Tygee Valley, and under the Booth spring, on upper Crow Creek, but on authority of uncertain value. Whether the underlying solid salt will prove to be a mass of rock salt with small amounts of disseminated red clay, as at Crow Creek, or whether the salt occurs in gravels incrusting the pebbles is conjectural.

Shallow digging or drilling would undoubtedly display the character and amount of salt available under the brine-spring areas.

Rough estimates of salt bodies underlying the brine springs.—Definite estimates of the amount of salt underlying the brine areas are, with the present data, impossible. Although the existence of rock salt underneath is more or less demonstrable, the thickness and continuity of the salt bodies, or old alkali flats, is problematic, particularly in the absence of any borings. From surface indications, however, it appears probable that the salt body to the west of the Stump and Tygee forks is more or less continuous from the Petersen spring northward to the McGrew residence, or nearly a mile. The Reed springs draw upon a probably large acreage of salt underlying the red clay terrace near by, on the west side of Stump Creek. The acreage of the salt body supplying the Draney spring, in Tygee Valley, is wholly conjectural in the absence of borings. At the old Stump and White springs, on upper Stump Creek, the narrow valley and the presence of bedrock on both sides suggest a very small salt body, not much exceeding a couple of acres. The salt body supplying the Booth spring, in upper Crow Creek, if it underlies any large part of the red-clay terrace, would be very extensive. In the absence of diggings or other data, however, its extent is problematic.

Rough estimate of rock-salt body on Crow Creek.—The rock salt on Crow Creek has been penetrated for a thickness of 20 feet. Not only is the bottom not in sight, but the salt becomes purer at that depth, containing less clay than at the top. This suggests a great thickness at the particular points penetrated. The rock salt appears to underlie much of the terrace of red clays near the mouth of Rock Creek, but that the salt extends to any great extent under Crow Creek valley in front of the terrace seems improbable, though by no means impossible. The extreme north end of the terrace may not contain any salt; fresh-water springs emerge here. The south end of the terrace has been cut through by Rock Creek and may perhaps also prove now destitute of salt. Conservative estimates of the portion of the terrace regarded as in all probability now underlain by salt indicate an area of approximately 113 acres. On the assumption that an average thickness of 15 feet can be mined out or dissolved out, this area would yield a little over 74,000,000 cubic feet of rock salt. By weight this would produce a trifle over 5,000,000 short tons of soluble salt (the rock salt being assumed to average 8 per cent clay and solid matter and 92 per cent soluble salt).

Possibility of salt in Star Valley.—The existence of anticlines in the sandstones of the Beckwith formation in the hills on the west side of Star Valley and the presence in places of the Pleistocene stony red clays suggest the possibility that old buried salt flats may exist under portions of the valley. None of these have yet come to light, so far as known, but unless local conditions prevented the formation here of pre-Pleistocene salt flats it is probable that future diggings may discover buried salt bodies in some portions of Star Valley proper.

SUMMARY AND CONCLUSIONS.

The workable areas along the Idaho-Wyoming border consist of isolated patches of salt bodies. These were formed during a long period of pre-Pleistocene climatic aridity by salt-bearing waters from the lateral streams (either surficial or underground drainage), which reached the valley bottoms, evaporated, and left their salt behind, either on the surface or in the gravels. The existence of anticlines and domes near by in the porous sandstones and conglomerates of the Beckwith formation had aided in the accumulation of salines to intensify the salinity of some of the drainage. The salt flats produced have been preserved by a covering of Pleistocene stony red clays.

Although the salt bodies or old alkali flats are thus meager in extent, especially in comparison with the other prominent salt-producing areas of the United States, the conservative estimate of 5,000,000 tons for the Crow Creek rock-salt body and the possibility of a larger salt body near the Tygee and Stump Creek forks indicate that the amount of salt apparently in sight in some of the present areas would be sufficient (if proper railroad connections existed) to yield returns on large-scale workings for a long time. It also appears quite probable that all the areas, including the smaller brine springs, contain sufficient salt to return the sums that may be advisedly invested in their development.

As to quality, salt can be easily obtained here which is above the average in chemical purity, as is indicated by the representative analyses given. This salt could be produced most cheaply and with the maximum of cleanliness by a process of solar evaporation.

At present the market for the salt of the area described is limited to the immediate vicinity, owing to the absence of railroad connections. With a railroad in Star Valley, however, the salt of this area would command the markets of eastern Idaho, western Wyoming, and much of Montana.

ANSAS.

Kansas ranked fourth in both quantity and value of salt produced in 1909. The production of the year was 2,769,849 barrels, or 387,779 short tons, valued at $782,676, as compared with an output in 1908 of 2,588,814 barrels, or 362,434 short tons, valued at $882,984. Salt was produced on a commercial scale in Kansas in 1909 at Hutchinson, Reno County; Lyons, Little Rock, and Sterling, Rice County; Ellsworth and Kanopolis, Ellsworth County; and Anthony, Harper County. Many of the salt manufacturers use the grainer process, in which steam is employed in the evaporation. The open-pan process, in which the heat is applied directly, is also used. The combination of open-pan and grainer process with steam as the source of heat is also employed. The plant of the Kingman Salt Mining Company, at Kingman, is abandoned.

Comprehensive accounts of the salt industry in Kansas by Samuel Ainsworth,[a] and C. M. Young[b] have recently appeared.

LOUISIANA.

Louisiana ranked fifth among the States in quantity of salt produced in 1909, and seventh in value of output, being exceeded in the latter respect by Michigan, New York, Ohio, Kansas, California, and Texas. The salt mined in Louisiana came from Weeks and Avery Islands, so called, located in Iberia Parish.

Of the producing localities, Weeks Island is located on the east shore of Weeks Bay, an eastern lobe of Vermilion Bay. It is sometimes called Grande Côte, on account of its size, though it is scarcely 2 miles in diameter. Prospecting for salt began here in 1897, and in 1898 the Myles Salt Company, which works the deposits at present, was organized. After considerable prospecting with the drill, the location of a shaft was determined on in 1898, and in March, 1902, the 600-foot level was reached and tunnels to the east and west were driven. The extreme depth of the shaft is now 645 feet.[c] To the north of the shaft the salt is impure; to the west there is danger of the tunnel running out of the salt and into the overlying sand, hence of ruining the mine; to the east the salt is excellent, and there seems to be no danger ahead.

The following descriptions of the mine operations are abstracted from those of Harris:[d] Mining is carried on by first undercutting or blasting out triangular chunks of salt on the level with the floor of the mine, then blasting down layer after layer, so to speak, already undermined. The drills are worked by compressed air furnished by the compressors in the power house at the surface. The salt is conveyed to the vicinity of the shaft in small dump cars drawn by mules over narrow-gage steel tracks. At the shaft the salt is passed through the crusher and falls into a huge bin below. From this it is drawn off into a 5-ton self-dumping cage that is capable of making a round trip—that is, from the bottom of the shaft to the top of the mill at the surface and back to the bottom of the shaft—in four minutes. The capacity of the mine, then, is about 75 tons per hour or 750 tons per ten-hour day.

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[a] Eng. and Min. Jour., September 4, 1909, pp. 454-456.
[b] Idem, September 18, 1909, pp. 558-561.
[c] Harris, G. D., Rock salt in the State of Louisiana: Bull. Louisiana Geol. Survey No. 7, 1908, p. 5.

The mine is lighted by electricity. Ventilation is usually fair, but much less satisfactory than it would be if there were provided an entrance and an exit shaft for the air in distant parts of the mine. Fire damp or inflammable gases are practically unknown in this mine. In the engine room a pair of 20 by 30 foot engines, geared back 3½ to 1, turn an 8-foot drum that winds up the cable lifting the cage. As usual with such machinery, there is a device so actuated by the motion of the engines that the engineer knows at every instant just where in the shaft the cage is, just when to stop the engines to bring the cage to the main floor or to the bottom of the mine, or just when he must gradually bring the engines to a standstill while the cage is automatically dumping its cargo into the bins at the top of the mill.

Besides these engines for hoisting there are two air compressors for working the drills in the mine and one small engine for working the ventilating fans. The power used to run the crusher at the bottom of the shaft, as well as the screens and the general millwork above, is transmitted by insulated wire cables from a dynamo in the engine room. The various boilers use fuel oil.

Salt of various coarseness is produced at the mill by grinding the crushed material as it is dumped from the cage, as already described, on the uppermost floor of the building through screens of varying mesh, the coarser grades being first screened out and the finer ones later on and lower down. Shipment is made via the Salt Mine branch of the Southern Pacific Railroad, sometimes in bulk, sometimes in carload lots, and sometimes in sacks. The highest priced salt is that shipped in huge chunks, used by cattlemen for salting their stock. In a moderately dry climate these chunks last a year or more, or until consumed by the cattle. The Myles Salt Company has kindly furnished the following data regarding the uses to which these various grades of salt are put:

> The crushed salt, grades Nos. 1, 2, and 3, is used in refrigerating, curing hides, curing fish, making salt pickles, glazing in enameling and pipe works, and No. 3 is especially adapted for capping all sorts of meats put up in pickle in barrels. The C (coarse) and F (fine) salt is used for dry-salting meats, clearing oleomargarine, and in all sorts of chemical works. The A grade is a special one made to suit the customer who regards No. 1 as too large and the C as too small for his purposes, such as making ice cream and pickles. The D grade is also a special one, consisting of powdered salt which results from the grinding of any of the crushed grades in the mill and which is used for any purpose where rapid solution of the salt is desired.

Salt is also mined on Avery Island, so called, located in Iberia Parish, 10 miles southwest of New Iberia. The workings on this island also have been described by Harris.[a] Rock salt was discovered here in 1862, and an 8 by 8 foot shaft, 83 feet deep, was sunk in 1867, whose depth was afterwards increased to 90 feet. Mining was carried on by driving long, narrow chambers in an east-west and finally in a north-south direction as well. The mine was afterwards flooded. In 1885 the shaft was deepened to 168 feet. It was subsequently flooded a second time. A new shaft was begun in 1899.

The details connected with the new mine are as follows: The shaft is 21 by 10 feet, is 518 feet deep, and is divided into two hoists and one air shaft. The galleries, about a mile of which were driven in 1904, are 30 feet wide, and run in two directions at right angles with each other, leaving square pillars 30 feet on a side as supports.

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[a] Op. cit., p. 14.

Here, as well as at Weeks Island, the salt is conveyed from the place of mining to the foot of the shaft by means of small cars drawn on a narrow-gage steel track by horse or mule power. Here, however, the cars are drawn upon the platform of the cage and hoisted and dumped by hand at the top floor of the mill. The heavy crushing is therefore done in the mill instead of at the foot of the shaft, as at Weeks Island. The various grades of salt produced are used for practically the same purposes as similar grades from Weeks Island. The purity of the salt is such that no purification processes are required. The salt is simply crushed, screened, ground, and winnowed to drive off the fine salt-dust particles. The elimination of the finest, dustlike particles is necessary owing to their tendency to deliquesce and cement together the larger salt grains.

MICHIGAN.

Michigan ranked first among the States in 1909 in both quantity and value of the salt produced. The output was 9,966,744 barrels, or 1,395,344 tons, valued at $2,732,556. There is included in these figures the salt contained in the brine that is worked up into soda and other chemicals. Though the salt contained in the brine does not appear on the market as such, it is, obviously, a part of the salt wealth of the State.

According to Norman B. Beasley,[a] there is now going on in the salt industry in Michigan a transformation almost as radical as that which occurred when Michigan lumber first brought out Michigan salt. It is a change from a system in which fuel economy was not an object to one in which fuel economy will be the main consideration. Much of the future salt supply of Michigan is destined to be obtained by means of mineral fuel, under which condition the cost of the fuel becomes a directly important factor in salt production, or indirectly so where exhaust steam is used. Either of these situations forces upon the salt producer a realization of the fact that steam costs money. Economy and efficiency, therefore, become important factors.

To secure reliable data on steam economy and evaporative efficiency, George B. Willcox, of the Willcox Engineering Company, Saginaw, has made a number of evaporative tests of salt-producing apparatus of different kinds. Some of these tests were made on salt grainers. The object of the tests was: (1) To determine the amount of steam required to produce a barrel of salt of 280 pounds; (2) to record for future reference variations in the temperature of the brine as evaporation proceeded; (3) to ascertain the amount of brine required to make a barrel of salt; (4) to record the fluctuations in steam pressure, pressure of the atmosphere, temperature of the air above the grainers, and temperature of the outside air, in order to show, if possible, the effect of these factors on the economical production of salt.

No attempt was made to secure especially favorable conditions, the plant being run during the test exactly as the salt maker had been accustomed to run it. The salt was obtained from a natural brine, and the steam for the salt plant was exhaust steam from a factory, containing 3 per cent moisture, with a pressure averaging 1.6 pounds

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[a] Eng. and Min. Jour., June 5, 1909, p. 1150.

per square inch. The run was divided into eight intervals, as shown in the following table:

Brine evaporation with exhaust steam.

Period.	Hours.	Salt, pounds.	Steam, pounds.	Pounds per hour.		Pounds of steam required to produce 1 pound hot salt.
				Salt.	Steam.	
1	9	....	26,320	....	2,924	....
2	37	25,297	91,354	684	2,466	36.05
3	53	32,968	110,570	623	2,086	33.48
4	17½	11,783	39,396	673	2,245	33.36
5	34½	20,896	69,286	605	2,008	30.1
6	4	2,468	17,594	617	1,898	30.76
7	24	10,640	45,452	443	1,477	31.8
8	13	6,900	24,040	531	1,849	34.9

By comparing the total steam condensed in any period with the total salt produced in that period, there is obtained the number of pounds of steam required to produce a pound of salt. The cost of the steam being known, the cost of producing a pound of salt during each of the given periods may be readily calculated. An analysis of the conditions existing during that period also throws light on the conditions required for economical production. There are many factors in the problem on which data are still not available, such as specific gravity of the brine, changes of ventilation in the grainer, agitation of the brine surface, and depth of brine above grainer pipes.

NEVADA.

Nevada salt was produced in Churchill, Esmeralda, and Washoe counties in 1909. The salt is almost all obtained by solar evaporation. The production in 1909 amounted to 16,107 barrels, or 2,255 tons, valued at $19,847. There was a considerable growth in 1909 as compared with 1908, for which year the corresponding figures were 9,714 barrels, or 1,360 tons, valued at $4,785.

NEW MEXICO.

Torrance County furnished the only commercial salt reported in this Territory. The salt was produced by solar evaporation.

NEW YORK.

Production and trade conditions.[a]—New York ranked second in both quantity and value of salt produced in 1909. The quantity of salt produced was 9,792,815 barrels, or 1,370,994 tons, valued at $2,430,245, as compared with 9,076,743 barrels, or 1,270,744 short tons, valued at $2,136,738, in 1908. The production is fixed by the trade requirements, which show only a moderate increase from year to year. The capacity of the active mines and plants is largely in excess of the output, and there are many plants now idle that could readily resume operations if conditions warranted. With the marked increase of production in

[a] Newland, D. H., Mineral Industry for 1909, pp. 630–631.

Michigan and the Middle West during late years, the New York producers have had to find their markets for the most part locally or in the New England States, where they receive incidental protection from the differential freight rates due to shorter haulage. But for this advantage the by-product salt of Michigan would make serious inroads upon their markets. Foreign salt from the West Indies and the Mediterranean countries is a strong competitor with the New York product for the trade of the seaboard towns of New England, and imports will probably increase in the future, as the Payne-Aldrich tariff bill reduced the duty by 20 cents a short ton on all grades of salt.

In addition to the salt used as such the figures of production given above include the brine that is converted into various chemicals, as, for example, by the Solvay Process Company, at Solvay, near Syracuse.

Occurrence.—Salt in New York occurs in the form of brine and also as rock salt. Brine is found at Syracuse in glacial drift, and in some places wells more than 300 feet deep have been sunk to the salt water. The brine from the shallow wells becomes weaker after continuous pumping, but the deeper wells apparently are not thus affected. From the Syracuse brine the salt is manufactured either by artificial or solar evaporation. The solar salt is made almost entirely in Onondaga County, and Syracuse has long been the center of the industry, which dates back more than one hundred years. In 1797 the Syracuse district was made a State Indian reservation, and most of the salt wells are now located on the reservation. The brine, which contains 17 to 20 per cent of sodium chloride, is furnished to operators at a fixed charge.

The rock-salt beds of New York occur in the red shales of the Salina formation in the Silurian. So far as known, they outcrop nowhere at the surface, but the area which they underlie and their mode of occurrence have been fairly well defined by numerous drill holes driven to them. They have been found from the Oatka Valley, in Wyoming County, east to Morrisville, Madison County, and south of this wherever wells have been driven down to their horizon, but they are not known to extend north of the forty-third parallel. Rock salt has been found also in Erie County, south of Buffalo. The manufacturers of salt from these beds obtain their supplies from wells driven to the rock salt. Water is introduced into the wells and then pumped up after nearly complete saturation. In this way a brine carrying nearly 25 per cent sodium chloride is obtained.

The salt produced in New York in 1909 came from near Syracuse, in the Onondaga district, Onondaga County; Le Roy, Genesee County; Cuylerville, Piffard, and Retsof, Livingston County; Watkins, Schuyler County; Ithaca and Myers, Tompkins County; Perry, Rock Glen, and Silver Springs, Wyoming County.

OHIO.

Ohio ranked third among the States in both quantity and value of the salt produced in 1909, being exceeded by Michigan and New York. The production amounted to 3,684,775 barrels, or 515,868 tons, valued at $993,700, as compared with an output of 3,427,478 barrels, or 479,847 short tons, valued at $864,710, in 1908, an increase in 1909 of 257,297 barrels, or 36,021 short tons, in quantity and of $128,990 in value. A complete description of the salt deposits of Ohio and of their historical development and present mode of working has been published in a recent bulletin of the Ohio Geological Survey by J. A. Bownocker, referred to in the bibliography at the end of this chapter. In this report for the year 1907 a brief description of the salt industry of Ohio was given, which was compiled from that source.

Salt production in Ohio is confined to two districts, the northeastern district, comprising Cuyahoga, Medina, Summit, and Wayne counties, and the southeastern district, in which is included Meigs County. The vacuum-pan and the grainer processes, or a combination of these processes, are employed by the salt manufacturers. The heat is either applied directly or in the form of steam.

OKLAHOMA.

The small production of salt reported from Oklahoma in 1909 came from Harmon County. No production was reported from Blaine County.

PENNSYLVANIA.

As heretofore, the salt output of Pennsylvania was reported from Allegheny County.

TEXAS.

The quantity of salt produced in Texas in 1909 was 409,315 barrels, equivalent to 57,304 short tons, valued at $260,286; in 1908 the corresponding figures were 442,571 barrels, or 61,960 short tons, valued at $255,652, a slight decrease for the year 1909.

Salt occurs in lagoons along the Gulf coast of Texas and in many "salines" or lakes throughout the State. The regions of greatest importance are Anderson and Van Zandt counties, in the eastern part of the State, and Crane and Mitchell counties, in the western part.

UTAH.

The production of salt in Utah in 1909 amounted to 246,935 barrels, or 34,571 tons, valued at $147,318. The production was slightly in excess of that of 1908, which was 242,678 barrels, or 33,975 tons, valued at $169,833. The salt is reported from San Pete, Salt Lake, Sevier, and Weber counties. In Salt Lake County, salt is obtained from the water of Great Salt Lake by the Inland Crystal Salt Company. An account of the methods of refining the salt employed by this company has been published by Leroy A. Palmer,[a] from whose article the following notes are taken.

The brine from which the salt is obtained is pumped from near the bottom of the lake, the reason for which is that the denser solutions tend to sink and the supernatant layers are therefore relatively less concentrated. The shore of the lake is level for many miles around and the work of pumping is easy, a 75-horsepower motor being sufficient to drive the 15-inch centrifugal pump, which raises 7,000 or 8,000 gallons per minute against a head of 15½ feet. The pump discharges to a flume, which carries water by gravity to the

[a] Min. World, July 24, 1909, p. 225.

beds on a 1,100-acre field. The first field is known as the settling pond. Here the brine is allowed to stand until all dirt, sand, etc., have settled, during which process the first stages of evaporation are in progress. After a sufficient time has elapsed for settling, the brine is drawn off to the stock pond and evaporated until the salt in solution has almost reached the point of deposition. The brine is then run to the third pond, known as the salt gardens, and left for complete evaporation.

Pumping is begun from the 15th of May to the 1st of June each year, and is carried on until the 1st of September, these being the months when the lake is highest. The crop for a year will vary from 3 to 5 inches in depth over the 9 salt gardens, each of which has an area of 20 acres. Plows are set to work after evaporation is complete, and the crop is loosened and wheeled into stacks of 700 to 800 tons each.

VIRGINIA.

Although salt is produced in Virginia, it is not marketed as such, but is worked up into chemicals by the Mathieson Alkali Works, located at Saltville. As this is the only company producing salt in this State, the statistics of production are combined with those of other States.

WEST VIRGINIA.

The output for West Virginia in 1909 amounted to 150,492 barrels, or 21,069 tons, valued at $76,463, as compared with a production of 145,157 barrels, or 20,322 short tons, valued at $70,481, in 1908.

The salt industry in West Virginia has recently been described by G. P. Grimsley,[a] from whose description the following notes are taken: The salt industry in this State is confined to two localities: (1) Malden, in Kanawha County, located 6 miles above Charleston, on the Kanawha and Michigan Railroad, on the north bank of Kanawha River, and (2) Mason and Hartford, Mason County, on Ohio River opposite Pomeroy, Meigs County, Ohio. In 1909 salt was reported from both these districts.

Malden.—There is one plant still in operation at Malden, which is owned and operated under the firm name of the J. R. Dickinson Salt Company.

The brine is pumped to a central plant by compressed air from three of the six wells; then into a large wooden storage tank, 60 by 25 by 4 feet, holding 44,800 gallons. The wells are 800 to 900 feet deep, with a 6½-inch to 7-inch casing containing a 2-inch brine pipe and a ½-inch compressed-air pipe.

From the storage tank the brine flows through a wooden pipe by gravity to the pans, which are heated by 15 gas jets. Coal is also employed as fuel, and 60 to 75 tons a week are used. The coal comes from the company's own mines at Quincy, 7 miles up the Kanawha and Michigan Railroad. The brine pans are three in number; the first one is 45 by 10 by 3 feet, and the other two are 30 by 8 by 3 feet. The brine is concentrated in these pans from a specific gravity of 1.048 to 1.063 with 7.1 to 9.3 per cent salt to a specific gravity of 1.085 with 12 per cent salt.

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[a] West Virginia Geol. Survey, vol. 4, pt. 2, 1909, pp. 286–354.

The brine from the pans is colored by suspended iron oxide, mud, and sand, and is drawn off to the upper side of the first mud settler. The two mud settlers are long vats constructed of heavy plank, 165 by 8 to 10 by 1½ feet, and divided longitudinally through the center by a plank partition. The brine entering the upper side flows to the opposite end and there passes over a low place in the partition into the lower side and back to the head of the vat again. It there passes through a pipe into the second mud settler constructed on a similar plan and in which it follows a similar course. By the time it reaches the head of the lower side of the second mud settler, it is perfectly clear and free of iron oxide, mud, and sand. In the meantime the brine has been kept at a moderate temperature by the heat of steam in copper pipes running through the settlers.

The brine leaves the second mud settler with a specific gravity of about 1.125 or with 17.2 per cent salt, and flows into the first of two settlers of the same size as the mud settlers but divided by two longitudinal partitions into three compartments. The brine from this settler passes into a fifth vat, or draw settler, which is 165 by 14 feet by 45 inches. This vat is without partitions and has 5-inch copper steam pipes. Here the brine is further concentrated and salt crystals begin to form. It is then conveyed to the four grainers, which are plank vats 150 by 10 feet by 18 inches lined with clay tile plates, and containing three copper steam pipes their full length. In these the salt is deposited and removed by rakers to the salt cars and then conveyed to the storage house.

After most of the salt is precipitated and the brine has a gravity of 30° Baumé, the liquor is drawn into the tenth or bittern vat, heated by two copper steam pipes, where it is further concentrated and the rest of the salt precipitated. This salt is impure and slightly discolored. It is, therefore, sold for agricultural purposes; or at this plant most of it is sold to the Kelley ax factory at Charleston, where it is mixed with other materials to form a tempering mixture for steel. When the mother liquor has reached a gravity of 35° Baumé it is removed to the bittern water tank, to be treated for bromine and calcium chloride.

Geology of the Kanawha brines.—The record of a gas well located on Cool Spring branch of Burning Springs hollow, about 3 miles from the Malden salt plant, throws some light on the geology of the horizon from which the brine is obtained. The record of the well, which is known as the Edwards well No. 1, has been published by I. C. White.[a] According to White, the sandstone known to the oil men as the "Salt sand" furnishes the brine in the Kanawha Valley. This sandstone belongs to the Pottsville formation and lies very near the base of the coal measures.

Mason.—The other operating salt plants in West Virginia are located at Mason and Hartford, Mason County. These plants are only 3 miles apart and the former is located opposite the salt works at Pomeroy, Ohio. Of the 13 plants which operated here in the seventies, not more than 3 are now making salt. The wells from which the brine is obtained are 1,250 feet deep and the brine comes from a depth of 1,100 to 1,150 feet. It is pumped by sucker rods from the depth of 600 to 800 feet into the storage tank, from which

[a] West Virginia Geol. Survey, vol. 1, p. 272.

it flows to the furnace pans. These are in three sets, each containing 10 pans bolted together. The pans measure 8 by 3 feet. There is also a single open pan 30 feet long and 8 feet wide. Over all these pans is the steam box made of plank.

The heated brine is conveyed from the furnace pans through a wooden pipe to the first, second, and third mud settlers in succession, which are similar in construction and operation to those at the Malden plant. From these it passes into two draw settlers. The long vats are heated by low-pressure steam from the steam box, conveyed through wooden log pipes to 4-inch copper pipes in the vats. The brine is drawn from the draw settlers into five salt grainers, 80 by 10 feet, which are lined with clay tiles. The mother liquor is drawn into a sixth grainer, or the bittern vat, from which it goes to the bittern tank.

Hartford.—Hartford is located 3 miles above Mason on Ohio River. The plant of the Hartford City Salt Company is located at the upper end of town between the railroad and the river. The brine is pumped from five wells into storage tanks located on the hills above the plant, from which it flows by gravity into the furnace pans, where it is heated. From these it passes to the mud settlers; thence to the draw settlers, 145 by 12 feet. From the draw settlers it goes to the grainers, which are 126 by 12 feet. These are equipped with automatic salt rakers which push the salt forward at a rate of 4½ feet a minute, discharging it upon a conveyor belt which carries it to the storage houses.

The plant of the Liverpool Salt Company is located at the lower edge of the town of Hartford and to the south of the railroad track.

The process of manufacture of salt from brine at this plant is similar to that at Malden. Tubular boilers, 72 inches in diameter and 18 feet long, are used for the production of high-pressure steam for use in the evaporation of the brine in the grainers.

The salt wells are 1,100 to 1,200 feet deep and have 600 feet of brine in them.

Geology of the Mason brines.—The geology of the brine horizon at Mason is presumably the same as that at Pomeroy on the opposite side of Ohio River. On the Ohio side the geology has been worked out by J. A. Bownocker and published in Bulletin 8 of the Ohio Geological Survey. The description of the geology of the Pomeroy district which has been published in a former report [a] may be repeated here.

The surface rocks in the Ohio Valley near Pomeroy lie at the summit of the Conemaugh formation, formerly known as the "Lower Barren Coal Measures." The depth of the wells in the region has undergone great variation. At first they were shallow, but were later extended to greater depths as the supply of brine became exhausted near the surface. When the supply from these deeper wells proved inadequate, they were sunk to greater depths.

When drilling first began in Ohio the water in the wells is said to have risen nearly to their heads, and in some cases to have actually overflowed. As pumping progressed the reservoirs of brine were lowered, and at the same time the tubing was extended deeper into the wells, the tubing following the brine in its descent. The density

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[a] Mineral Resources U. S., for 1907, pt. 2, 1908, p. 666.

of the brine has increased in the direction of the dip of the rocks, that is, to the southeast. The quantity of brine that has been taken from these rocks is enormous and is much more than the capacity of the rocks at any one time. This great excess has doubtless been derived from surrounding territory. The brine-bearing strata dip toward Pomeroy from the northwest, and as the brine has been removed from the wells the supply has been renewed from the rocks lying at higher levels to the northwest. The brine was doubtless once a part of the ocean, and as the sand or gravel now comprising the salt-bearing rocks was deposited on the ocean floor, sea water filled the spaces between the grains and pebbles, and has remained since in that position. It must be borne in mind, however, that the Pomeroy brines were probably very near the shore, perhaps within a landlocked sea, and hence might vary considerably from those in the open ocean. This fact explains the presence of the relatively large quantities of bromides and iodides, since these substances are contained in certain marine plants. It is possible that conditions were very favorable for these plants in the early sea in the vicinity of Pomeroy.

HAWAII.

A production of 7,796 barrels, corresponding to 1,091 tons, of salt, valued at $5,292, was reported to the survey from Hawaii in 1909.

PORTO RICO.

The production of salt in Porto Rico in 1909 amounted to 166,790 barrels, or 23,351 short tons, valued at $26,810.

DOMESTIC CONSUMPTION

The following table shows the proportion of salt produced in the United States entering into domestic consumption. Of the total consumption of salt during 1909 in the United States, 96.6 per cent was of domestic production, and only 3.4 per cent were imported. The country, therefore, is producing practically all the salt it needs for its own use. The condition of the industry is practically what it was two years ago.

Supply of salt for domestic consumption, 1880–1909, in barrels.

Source.	1880.	1890.	1900.	1908.	1909.
Domestic production	5,961,060	8,876,991	20,869,342	28,822,062	30,107,646
Imports	3,427,639	1,838,024	1,427,921	1,140,306	1,067,999
Total	9,388,699	10,715,015	22,297,263	29,962,368	31,175,645
Exports	4,436	17,597	53,650	190,192	286,810
Domestic consumption	9,384,263	10,697,418	22,243,613	29,772,176	30,888,835
Comparison with preceding year		+877,610	+1,274,634	−774,791	+1,116,659
Percentage of imports to total consumption	36.5	17.2	6.4	3.8	3.4

IMPORTS.

The table given below shows that the imports of salt into the United States decreased during 1909 as compared with 1908, in both quantity and value. The importation of salt into this country has been on the decline for many years. The quantity of salt imported in 1909, namely, 299,039,757 pounds, or 1,067,999 barrels, is the smallest recorded by the Geological Survey, except in 1907 when it was 1,441,363 pounds, or 5,148 barrels, less than in 1909. The value of the imports likewise has experienced a steady decline, reaching its lowest figure, $437,827, in 1909. The decline is not confined to any particular grade of salt but is shown in all the grades imported, and chiefly in the salt imported in bulk.

According to figures obtained from the Bureau of Statistics of the Department of Commerce and Labor the quantity and value of the salt imported and entered for consumption in the United States in the last five years is as follows:

Salt imported and entered for consumption in the United States, 1905–1909, in pounds.

Year.	In bags, barrels, and other packages.		In bulk.		For the purpose of curing fish.		Total quantity.	Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.		
1905	73,252,959	$247,853	155,091,301	$153,914	93,972,951	$90,422	322,317,211	$492,189
1906	74,228,878	257,592	159,674,675	149,944	115,359,107	101,326	349,262,660	508,862
1907	74,762,435	242,377	115,826,979	108,166	107,008,980	100,739	297,598,394	451,282
1908	66,409,270	219,272	153,031,808	120,979	99,844,560	104,439	319,285,638	444,690
1909	65,581,839	220,503	135,735,445	132,884	97,722,473	84,440	299,039,757	437,827

EXPORTS.

The exports of salt of domestic production from the United States from 1905 to 1909 is shown as follows:

Salt of domestic production exported from the United States, 1905–1909.

1905	pounds	68,475,356	$239,223
1906	do	67,976,581	274,627
1907	do	61,603,422	232,895
1908	pounds	53,253,739	$202,338
1909	do	80,306,820	269,273

The exports of salt have increased heavily during the last ten years. In 1899, the exportation amounted to 25,200,191 pounds, valued at $86,465, and these figures are very large as compared with those of any of the preceding years and the three years following. Since 1902, the exportation has increased very rapidly, the rate of increase in 1909 being particularly high.

BROMINE.

PRODUCTION.

The following table gives the production and value of the bromine produced in the United States since 1880. The production from Michigan is reported in the form of potassium bromide, and it has been found impracticable to separate the bromine from the potassium.

Production and value of bromine, 1880–1909.

1880......pounds..	404,690	....	1896......pounds..	546,580	$144,501
1883........do....	301,000	....	1897........do....	487,149	129,094
1884........do....	281,100	$67,464	1898........do....	486,979	126,614
1885........do....	310,000	89,900	1899........do....	433,004	108,251
1886........do....	428,334	141,350	1900........do....	521,444	140,790
1887........do....	199,087	61,717	1901........do....	552,043	154,572
1888........do....	307,386	95,290	1902........do....	513,893	128,472
1889........do....	418,891	125,667	1903........do....	598,500	167,580
1890........do....	387,847	104,719	1904........do....	897,100	269,130
1891........do....	343,000	54,880	1905........do....	1,192,758	178,914
1892........do....	379,480	64,502	1906........do....	1,283,250	165,204
1893........do....	348,399	104,520	1907........do....	1,379,496	195,281
1894........do....	379,444	102,450	1908........do....	1,055,636	102,344
1895........do....	517,421	134,343	1909........do....	728,875	92,735

The bromine industry in the United States is centered in Michigan, Ohio, Pennsylvania, and West Virginia. The industry in West Virginia has been described by G. P. Grimsley,[a] from whose description the following notes are in part quoted and in part compiled. Bromine in West Virginia is manufactured at Malden, Kanawha County, a short distance southeast of Charleston, and near Mason and Hartford, Mason County, on Ohio River.

At the plant of the J. R. Dickinson Salt Company, at Malden, in the Kanawha valley, the bittern water goes to the bromine plant, where it is concentrated to 41° to 43° Baumé. The concentrated liquor then flows into sandstone stills, where it is mixed with sulphuric acid and potassium chlorate. About 25 pounds of acid and 8 pounds potassium chlorate are used to each 400 gallons of bittern, and the yield from this charge is about 25 pounds of bromine.

Steam is blown into the mixture, heating it to a temperature of about 180° F., and the bromine vapor passes off through lead pipes into a condenser. In the condenser the vapor is liquefied and runs into bottles, whose connections are sealed with clay to prevent the escape of fumes.

Calcium chloride is also made from the residual liquor after the bromine has been extracted. This liquor is drawn from below into a cistern, where it is treated with lime to neutralize the acid. It is then pumped into the "calcium" kettles. These kettles are inclosed in steam jackets and have a steam coil in them which furnishes the necessary heat. The liquor is heated and concentrated to a thick sirup, after which it runs into sheet-iron drums holding 600 to 700 pounds. In a short time the liquid cools and there is formed a solid mass of calcium chloride which is ready for shipment. In removing the material for use, the drums are cut or pounded off, leaving a solid core.

[a] West Virginia Geol. Survey, vol. 4, 1909, pp. 286–354.

At the Dixie Salt Company's plant at Mason, Mason County, the bromine plant is housed in a small shed separate from the main plant. It contains one furnace and two stone stills. The liquor containing the calcium chloride is taken across the river to the Pomeroy plant for further treatment.

At the plant of the Hartford City Salt Company the residual brine from the last grainer is drawn into the bittern vat and concentrated to 36° Baumé; it yields a small quantity of agricultural salt. The bittern is then heated in the bromine pan and the bromine is extracted in two stone stills. The liquor is then run into a tank where it is neutralized with lime. It is then boiled in the three "calcium" kettles by means of steam until a thick sirup is formed. This is run into sheet-iron drums, where it hardens into calcium chloride in from one to three days.

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SULPHUR AND PYRITE.

By W. C. Phalen.

SULPHUR.

PRODUCTION.

In 1909 sulphur was produced in the same States as in 1908, namely, Louisiana, Nevada, Utah, and Wyoming. As heretofore the bulk of the sulphur came from Louisiana. The production of this State, of course, still continues to be the main factor in the sulphur industry of this country, but the output in 1909 was smaller than that reported for 1906, 1907, or 1908. The production of Nevada also was smaller than for any one of the preceding three years. Utah produced a slightly greater quantity than in 1908, but less than in either 1906 or 1907. In Wyoming the production was considerably greater in 1909 than in 1908.

It is estimated that the production for 1909 was nearer the rate of consumption than in previous years, when large stocks were piled up.

Prices remained fairly constant throughout the year at approximately \$22 per long ton at New York for prime Louisiana sulphur, and \$22.50 at Boston, Philadelphia, and Baltimore. Quotations on roll sulphur were from \$1.85 to \$2.15 per 100 pounds, for flour sulphur the range was from \$2 to \$2.40 per 100 pounds, and for sublimed sulphur from \$2.20 to \$2.60 per 100 pounds. Sicilian sulphur was held at the same figure, but could not compete successfully with the American sulphur at even prices on account of the importer's inability to offer to the consumer the same facilities as the American producer and because of the natural preference in the United States for home material.[b] The production of the country since 1880 is shown in the following table:

Production of sulphur in the United States, 1880–1909.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
	Long tons.			*Long tons.*	
1880	536	\$21,000	1895	1,607	\$42,000
1881	536	21,000	1896	4,696	87,200
1882	536	21,000	1897	2,031	45,590
1883	893	27,000	1898	1,071	32,960
1884	446	12,000	1899	4,313	107,500
1885	638	17,875	1900	3,147	88,100
1886	2,232	75,000	1901	[b] 241,691	1,257,879
1887	2,679	100,000	1902	[b] 207,874	947,089
1888	....	....	1903	[b] 233,127	1,109,818
1889	402	7,850	1904	127,292	2,663,760
1890	....	....	1905	181,677	3,706,560
1891	1,071	39,600	1906	294,153	5,096,678
1892	2,400	80,640	1907	293,106	5,142,850
1893	1,071	42,000	1908	369,444	6,668,215
1894	446	20,000	1909	239,312	4,432,066

[a] Eng. and Min. Jour., January 29, 1910, p. 272. [b] Includes the production of pyrite.

OCCURRENCE.

LOUISIANA.

In the report on sulphur for 1907[a] the details of sulphur mining by the Union Sulphur Company in Calcasieu Parish, La., were described, and they will not again be outlined in the present report. The process has also been frequently described in the current scientific journals, among the more important recent articles bearing on the subject being the following: (1) "An improved method of mining sulphur," by Herman Frasch, president of the Union Sulphur Company and the inventor of the so-called Frasch process,[b] who notes the difficulties to be overcome in mining Louisiana sulphur and gives a description of a recent invention secured by him for this purpose. (2) "The sulphur mines of Louisiana," by D. A. Willey.[c] In this article Mr. Willey describes briefly the method of obtaining the sulphur and its subsequent treatment at the surface. (3) "Louisiana's domination of the world's sulphur trade," by Albert Phenis.[d] This article contains a brief history of the Union Sulphur Company, a brief description of the Frasch process, and a sketch of the commercial outlook of the sulphur industry, especially with reference to competition with Sicilian sulphur.

It was reported in the Paint, Oil, and Drug Review[e] that a large deposit of sulphur has been discovered about 6 miles north of Sulphur, La., not far from the Kansas City Southern Railway. The occurrence was found in drilling for oil. The rumored strike, if a fact, is of interest, as it indicates that the deposits of sulphur heretofore so extensively exploited by the Union Sulphur Company may underlie a much larger area than is commonly supposed.

NEVADA.

The sulphur mined in Nevada is produced by the Nevada Sulphur Company, near Humboldt, Humboldt County.

TEXAS.

In southeastern Texas it is reported that sulphur occurs in many places within a radius of 50 miles of Beaumont. At Spindletop several sulphur veins are known at different depths and it is predicted that the material can be profitably mined after the oil supply of the field has been exhausted. Sulphur has also been encountered in the Sour Lake field, also near Dayton, and on Pine Island Bayou west of Beaumont.[f] According to the Manufacturers' Record[g] sulphur occurs at Bryan Heights, near Velasco, Brazoria County. It is reported that the sulphur deposits will be soon developed and that it will be mined in much the same manner as in Louisiana.

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[a] Mineral Resources U. S. for 1907, U. S. Geol. Survey, pt. 2, 1908, p. 674.
[b] Min. World, December 4, 1907, pp. 1049 et seq.
[c] Eng. and Min. Jour., December 14, 1907, pp. 107 et seq.
[d] Mfrs. Rec., January 2, 1908, p. 85.
[e] June 2, 1909.
[f] Paint, Oil, and Drug Review, March 16, 1910.
[g] February 3, 1910.

UTAH.

The Utah sulphur deposits are locally known as the "Cove Creek beds"[a] and are located near Black Rock, Beaver County. The sulphur is found in beds of soft rhyolitic tuff, which some of the miners call "gypsum." The series in which the tuffs are found are thought to overlie Paleozoic sediments. The sulphur beds are located in or near a zone of intense faulting and volcanic activity which is not yet ended, and hydrogen sulphide (H_2S) is still escaping from the line of sulphur beds.

The sulphur occurs mainly as a dark-colored impregnation or cement in the rhyolitic tuff, but it is also found in cylindrical masses 10 to 15 feet in diameter, having a rude radial structure, and as irregular veins of pure yellow sulphur often several inches thick. The sulphur ore varies greatly in richness, from material containing only a trace to ore nearly 100 per cent pure. Material having as little as 15 per cent sulphur is considered paying ore.

The cost of production is considerably more than would be the case were operations conducted on a scale justifying the installation of labor-saving machinery. Surface stripping by horses and scrapers to a depth of 10 feet is practiced, and the ore is removed by manual labor and taken to the smelter. Here it is placed in iron retorts and melted by steam forced into it at a pressure of 60 pounds and at a temperature of 144° C. The liquid sulphur is drawn off through the bottom into iron receptacles and cooled in masses weighing 200 pounds. In this form it is stored until needed, when it is ground and shipped in sacks.

WYOMING.

According to E. G. Woodruff, the sulphur-smelting plant at Cody, Wyo., was abandoned early in 1908 and the equipment moved to the vicinity of Thermopolis, where new deposits were exploited and a more extensive equipment installed. So far as known there have have been no attempts to develop the deposits in the mountains northwest of Cody.

During 1909 the sulphur produced in Wyoming was mined by the Wyoming Sulphur Company, near Thermopolis. In a recent publication of the Survey[b] the Thermopolis deposit was described by Woodruff, from whose account the following description is taken:

> *Location and extent.*—The sulphur deposits are located 3½ miles northwest of Thermopolis, Wyo., on the gentle northeast slope of a small eroded anticline adjacent to the valley of Owl Creek, in sec. 21, T. 43 N., R. 95 W. A large number of drill holes put down in this area by the Wyoming Sulphur Company have found the deposits of sulphur in a zone about one-eighth of a mile in width and one-fourth of a mile in length, along the base of the anticline. * * * It is believed that the sulphur-bearing zone extends for a considerable distance * * * beyond the limits of the proved ground. One condition that is considered to point to the presence of sulphur within the area outlined above is the occurrence of deposits of travertine upon beds of altered limestone. This association of travertine and limestone seems to be necessary to the deposition of sulphur. * * *
>
> The minable sulphur deposits occur in the altered Embar limestone which lies immediately below the travertine and through which the sulphur-bearing waters passed in their course to the surface. The sulphur seems to be present in very irregular deposits or pockets about the sites of extinct springs, where the sulphur-bearing waters came into contact with the limestone. * * * There is no uniformity in the shape, size, or arrangement of these ore-bearing pockets. * * *

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[a] Lee, W. T., Cove Creek sulphur beds, Utah: Bull. U. S. Geol. Survey No. 315, 1907, pp. 485–489.
[b] Bull. U. S. Geol. Survey No. 380, 1909, pp. 373–380.

Native sulphur in this district occurs in two forms—in small yellow crystals filling veins or cavities in the rocks, and in a massive form where the original structure of the limestone is retained, but where the calcium carbonate is replaced by the sulphur. * * * Laterally a deposit may be rich at one point and barren 10 feet away. The sulphur ores thus vary from a low percentage associated with barren rock to small masses of almost pure mineral, but as the deposits follow no general laws all of the area where geologic conditions are favorable must be tested to locate the sulphur beds. * * *

Mining, smelting, and marketing.—The Wyoming Sulphur Company, of Thermopolis, Wyo., the only company operating in the area at the present time, began development in the fall of 1908. Mining is carried on in open-pit quarries, in which promising places are located, small drill holes are put down to prove the ground, the surface rock is removed from favorable sites, and the rock and ore are extracted by drilling and blasting. The rock is then broken to convenient size and sorted by hand, and all ore estimated to contain sufficient sulphur for treatment is hauled by wagon to the reduction works, one-fourth of a mile distant. At the smelter the ore is placed in bins, from which it is discharged into small steel cars with perforated sides, each holding about 2 tons. A string of three cars is then run into a large cylindrical retort, the door closed, and steam admitted at 60 pounds pressure for two hours. The sulphur is melted and flows to the bottom of the retorts, from which it escapes through a trap into bins, where it is allowed to cool. When the sulphur has been melted the cars containing the gangue are removed from the retort, other cars are admitted, and the process is repeated. This process is not considered highly efficient, as only about two-thirds of the sulphur which the rock contains is melted out; the remainder is lost in the refuse. After the sulphur is cooled it is crushed in an 8-inch Blake crusher and pulverized to an impalpable powder in a rotary grinder. It is then sacked and taken to Crosby, 8 miles distant, for shipment to various points in Wyoming and adjoining States.

Production.—The plant now installed has a capacity of 20 tons a day, but has not yet been operated to the full capacity. According to a statement of the superintendent of the company on December 15, 1908, the plant had produced up to that time 200 tons of sulphur and was then yielding 10 tons a day. The demand for ground sulphur is reported to be fairly good at $35 a ton at destination.

IMPORTS.

The returns for the year 1909 show that the total imports of sulphur into the United States were 30,589 long tons, valued at $549,632; for the year 1908 the corresponding figures were 21,136 long tons, valued at $362,379. The year 1908, however, was a period of business depression and the importation of sulphur was probably below what it would have been had business conditions been normal. On the other hand, as will be seen on a subsequent page, the exports in 1909 amounted to 37,142 long tons, valued at $736,928, the quantity of sulphur exported being 6,553 tons in excess of that imported. The United States is, therefore, amply able to take care of its own needs so far as sulphur is concerned.

In the following table the importation of sulphur for consumption is given for the last five years:

Sulphur imported and entered for consumption in the United States, 1905–1909, in long tons.

Year.	Crude.		Flowers of sulphur.		Refined.		All other. [a]		Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
1905	82,961	$1,528,136	572	$16,037	779	$19,960	27	$3,352	$1,567,485
1906	72,404	1,282,873	1,100	29,565	709	17,918	28	3,224	1,333,580
1907	20,399	355,944	1,458	41,216	606	14,589	60	8,426	420,175
1908	19,620	318,577	793	22,562	693	17,227	30	4,013	362,379
1909	28,800	492,962	770	23,084	966	26,021	53	7,565	549,632

[a] Includes sulphur lac and other grades not otherwise provided for, but not pyrite.

In the following table are given the statistics of imports by countries from which sulphur was imported into this country, and by ports at which it was received, for the years 1907 to 1909. The importation comes chiefly from Japan and Italy, the former country sending more than the latter. Japanese sulphur enters the United States through San Francisco, Cal., and Willamette, Oreg. According to the Engineering and Mining Journal: [a]

Sulphur importers all over the United States are much interested in the hearing before United States General Appraiser S. B. Cooper in the case of H. M. Newhall, of San Francisco, as protestant against the customs classification of sulphur from Bungo, Japan, as refined sulphur. Testimony has been taken recently at Portland and Seattle and further testimony will be taken in the matter at Lake Charles, La., and New York. The case of the Newhalls, San Francisco importers of this sulphur, has been taken as a test one from hundreds of similar ones. Duties on several million dollars' worth of sulphur depend on the final decision on this case. The Bungo sulphur is naturally so pure that it is not further refined before importing, so the importers claim it should be classed as crude, but the customs officials have been classifying it as refined. There is likely to be a conflict as to the intention of the tariff act. If it is to protect home refiners and the labor they employ, the custom-house will insist that this Japanese sulphur must pay duty as refined; and if it is to raise a revenue the same claim will be made. The importers claim that while the Japanese sulphur may in some cases be used direct as received from the mine, in other cases further manipulation is necessary before a perfectly pure sulphur is gained. Farmers all over the United States use fertilizers, in the manufacture of which sulphur is used, and an immense quantity is used in bleaching wood-pulp paper. The sulphur consumers are many and important. Fruit growers, match manufacturers, powder makers, sugar refiners, rubber manufacturers, and hundreds of others are interested in the substance.

The sources are in the Province of Bungo, Japan, on Mount Kujusan. The natural sulphur flows as such from the ground, and cooling, forms a mass of nearly pure sulphur, which is sacked on the spot and taken down the mountain on sleds, placed on wagons, and carried 50 miles to Oita and shipped to Kobe without the natural sulphur being in any way refined or purified. It is thus a natural or native product absolutely. The openings are really not mines, as the sulphur flows from fissures in the rocks and is collected in pools or drains. There are upward of 40 of the openings, and the sulphur seems to have been purified by passing through the porous volcanic rock through which it flows. Upon the decision of the Newhall case a large amount of money depends as well as heavy interests of importers and consumers.

Statement, by countries and by customs districts, showing the imports into the United States of crude sulphur or brimstone each calendar year, 1907–1909, in long tons.

Countries whence exported and customs districts through which imported.	1907.		1908.		1909.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
COUNTRY.						
Canada	....	....	26	$485	297	$7,235
United Kingdom	226	$4,654	....	13	2	58
Italy	3,393	60,152	12,950	197,203	10,369	194,834
Japan	16,699	292,361	7,055	119,457	15,800	250,639
Other countries	....	....	87	1,419	446	6,188
Total	20,318	357,167	20,118	318,577	26,914	458,954
CUSTOMS DISTRICT.						
Baltimore, Md	13	328	....	....	5,586	105,436
Boston and Charlestown, Mass	200	4,136	1	18	....	....
New Orleans, La	....	....	....	....	....	....
New York, N. Y	3,141	54,231	7,366	114,939	4,601	85,059
Philadelphia, Pa	....	....	....	....	....	....
Portland, Me	....	....	....	....	....	....
San Francisco, Cal	11,224	192,906	10,231	157,847	10,132	158,588
Willamette, Oreg	3,827	70,572	1,978	35,691	4,342	68,780
All other	1,913	34,994	542	10,082	2,253	41,091
Total	20,318	357,167	20,118	318,577	26,914	458,954

[a] December 17, 1910.

EXPORTS.

In 1909 the United States exported 37,142 long tons of sulphur, valued at $736,928; in 1908 this exportation amounted to 27,894 long tons, valued at $561,534.

PYRITE.

PRODUCTION.

The pyrite-mining industry was in a thrifty condition during 1909, although few new companies were reported to the Survey. The older and well-established concerns carried on exploratory work, improved their methods, and added to their equipment.

The scare over the Ducktown acid production had about subsided at the beginning of the year 1910. Although the Tennessee Copper Company operated one 400-ton unit of its acid plant throughout the year and was reported as constructing another unit of equal or greater capacity at the beginning of 1910, and the Ducktown Sulphur, Copper, and Iron Company operated its 180-ton plant after the latter part of June, no noticeable curtailment in the market for pyrite resulted. The reported failure of the attempt to reorganize the new fertilizer company possibly accounted in part for this.[a]

The production of pyrite in the United States in 1909 amounted to 247,070 long tons, valued at $1,028,184. This is an increase in quantity as compared with the preceding year, but the quantity produced is almost the same as that of 1907, during the greater part of which year business conditions were normal. The list of States producing pyrite remained the same as in 1908. Wisconsin is becoming more and more a producer of pyrite.

In the following table is given the production of pyrite in the United States by States during the last three years:

Production of pyrite in the United States, 1907–1909, by States, in long tons.

State.	1907.			1908.			1909.		
	Quantity.	Value.	Average price per ton.	Quantity.	Value.	Average price per ton.	Quantity.	Value.	Average price per ton.
Alabama and Georgia	28,281	$85,307	$3.02	23,915	$69,635	$2.91	15,848	$77,291	$4.88
California	51,950	174,549	3.36	30,545	131,744	4.31	51,266	254,235	4.96
Illinois and Indiana	4,929	14,713	2.98	4,905	14,157	2.89	8,332	23,046	2.77
Massachusetts and New York	30,671	126,991	4.14	[b] 40,362	186,126	4.61	[c] 47,987	[c] 221,299	4.61
Ohio	6,816	20,803	3.05	6,531	19,929	3.05	9,461	29,003	3.07
Pennsylvania	....	....	......	....	....	......	(d)	(d)	......
Virginia	124,740	372,586	2.99	116,340	435,522	3.74	114,176	423,283	3.71
Wisconsin	....	....	......	(d)	(d)	......	(d)	(d)	......
Total	247,387	794,949	3.21	222,598	857,113	3.85	247,070	1,028,157	4.16

[a] Chiefly quoted from the Eng. and Min. Jour., January 22, 1910.
[b] Includes the production of Wisconsin.
[c] Includes the production of Pennsylvania and Wisconsin.
[d] Included with Massachusetts and New York.

Production of pyrite in the United States since 1882:

Production of pyrite in the United States, 1882–1909, in long tons.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
1882	12,000	$72,000	1896	115,483	$320,163
1883	25,000	137,500	1897	143,201	391,541
1884	35,000	175,000	1898	193,364	593,801
1885	49,000	220,500	1899	174,734	543,249
1886	55,000	220,000	1900	204,615	749,991
1887	52,000	210,000	1901	[a] 241,691	1,257,879
1888	54,331	167,658	1902	[a] 207,874	947,089
1889	93,705	202,119	1903	[a] 233,127	1,109,818
1890	99,854	273,745	1904	207,081	814,808
1891	106,536	338,880	1905	253,000	938,492
1892	109,788	305,191	1906	261,422	931,305
1893	75,777	256,552	1907	247,387	794,949
1894	105,940	363,134	1908	222,598	857,113
1895	99,549	322,845	1909	247,070	1,028,157

[a] Includes production of natural sulphur.

PYRITE INDUSTRY BY STATES.

ALABAMA.

In 1909 the production of pyrite in Alabama fell slightly below the production of 1907 and 1906. The production of pyrite in this State has undergone a great reduction during the last few years. The pyrite was mined by the Alabama Sulphur Ore and Copper Company, which was active only part of the year. The mine of this company is located near Pyriton, Clay County.

CALIFORNIA.

California produced more pyrite in 1909 than any other State except Virginia. The output was much greater than in 1908, but almost exactly the same as in 1907. The enhancement in value of the 1909 product as compared with that of 1907 is out of all proportion to the relative production, which, as a matter of fact, was 200 tons less in 1909 than in 1907. California pyrite is reported from near Oakland, Alameda County, and from near Keswick, Shasta County.

GEORGIA.

Georgia produced considerably less pyrite in 1909 than in 1908. One of the Georgia companies leased its property, and it was worked only a part of the year. Georgia pyrite comes from near Acworth, Cherokee County, and from Villa Rica, about 30 miles west of Atlanta. At the latter place operations were conducted throughout the year and improvements were made on the property.

ILLINOIS.

The production of pyrite in Illinois in 1909 greatly exceeded that of 1908. A large number of new operators was added to the Survey's list. Pyrite in Illinois is obtained chiefly as a by-product in the mining of coal. The pyrite occurs in the coal in the form of concretions ("sulphur balls") or in thin slabs or plates seldom thicker than one-half to three-quarters of an inch and often as thin as a knife blade.

The miners are paid by the ton for loading the pyrite into the pit cars. Its handling, therefore, adds to their income and results in a cleaner and more marketable coal. Where high mining rates exist, and the coal is thick and easily mined, the miners are not so particular about picking out the pyrite. Where mining is not so easy, the pyrite is saved and the miners' wages thereby increased. At certain of the mines machinery for crushing and cleaning the pyrite has been installed. A finished product is obtained and sold directly to the sulphuric-acid factories.

INDIANA.

The production of pyrite in Indiana was not so great in 1909 as in 1908. As in Illinois, the pyrite is obtained in mining coal.

MASSACHUSETTS.[a]

The production of pyrite in Massachusetts was less in 1909 than in 1908. The old Davis mine near Charlemont caved in during the year and the workings are now filled with water. A new shaft known as No. 4 was sunk to the north of the old workings to a depth of 100 feet. Cross cuts were driven into the foot wall and hanging wall from the shaft. The rock exposed in the shaft was stained with iron oxide, indicating pyrite. This cap rock did not develop ore in the shaft. A narrow vein of ore, which is reported to be high grade, was developed in the bottom of the shaft. The ore from this vein indicates that it is narrow. The pyrite in the ore contains 40 per cent of sulphur. There is present also some concentrating ore. In general it closely resembles the Mount Peak ore.

At the Mount Peak property no work is being done at the present time (January, 1911). Two narrow veins of pyrite carrying some copper have been explored to a depth of 150 feet and prospected along the surface 600 feet. Their width varies from mere stringers to about 2 feet; the average width does not exceed 1 foot. The ore is high grade. Adjacent to one of the veins mentioned a concentrating ore has been exposed, but it has not been sufficiently explored to determine whether it is of value or not. No large outcrops of gossan have been discovered.

The only shipments being made at the present time (January, 1911) from Charlemont are concentrates obtained from milling the waste dumps. The low-grade ore from the dumps is fed to a jawbreaker from which it is elevated to a grizzly. The oversize is crushed by rolling, and the undersize from the crusher, and the product from the rolls is fed to a second set of rolls and then elevated to a trommel. The oversize from the trommel is in turn fed to oversize rolls and the product is elevated again to the trommel. The undersize ore is fed directly to two Harz jigs. The tailings from the jigs go to waste, and the concentrates, amounting to over 20 or 30 tons a day, are delivered to ore bins lined with steam pipes for drying the ore.

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[a] The notes on the pyrite occurrences near Charlemont, Mass., are from a private communication from Prof. Louis D. Huntoon, Yale University.

NEW YORK.[a]

The production of pyrite in New York in 1909 came from St. Lawrence County, where mining has been carried on intermittently for several years. The pyrite is associated with crystalline limestones and schists, and occurs in bedded veins, impregnated zones, and fahlbands, which in places widen into lenses or shoots similar to those encountered in the magnetite deposits of the Adirondack region, New York. The pyrite is associated with a quartz and feldspar gangue. The zones strike northeast and are conformable to the wall rock. The more important zones are found in a line extending from Gouverneur, N. Y., where the American Pyrites Company operated during 1907, northeast to the High Falls mine in the town of Canton. Pyrrhotite occurs in considerable quantity at the High Falls mine.

The St. Lawrence Pyrite Company was the only producer active in 1909.

OHIO.

The production of pyrite in Ohio increased 45 per cent in quantity and 46 per cent in value in 1909 as compared with 1908. The mineral is obtained by the various coal operators in the preparation of soft coal for market.

PENNSYLVANIA.

A slight production of pyrite was reported from Mercer County, Pa., in 1909. The pyrite is presumably obtained in connection with mining coal.

VIRGINIA.

Virginia was the largest producer of pyrite in the United States in 1909. Though the quantity and value of the product were large, they were slightly below the figures for 1908. The production of the State had been declining slightly for the few years previous to 1908. The output of the State comes from Prince William, Louisa, and Pulaski counties. In Prince William County pyrite was mined during 1909 at the Cabin Branch mine located at Dumfries. Some copper matte was also produced at this mine from smelting copper pyrite. The new 150-ton mill installed at this plant was reported as running since September, 1909. Sinking on the incline reached a depth of about 1,500 feet.

The following is an account by J. Tyssowski[b] of the mining methods practiced at the Cabin Branch mine:

The Cabin Branch mine.—The Cabin Branch mine, situated about a mile from Dumfries, in Prince William County, Va., has been operated with few interruptions since 1889. It is essentially a sulphur (pyrite) mine, although a 50-ton smeltery was erected at Barrows Siding, where the company's 6 miles of narrow-gage railroad connects with the main line of the Richmond, Fredericksburg and Potomac Railroad. The idea was to treat the copper ore sorted from the run-of-mine pyrites. Heap roasting was tried, but almost immediately abandoned, and from that time only cinder has been treated at infrequent intervals. At present the smeltery is not in operation.

The ore body at the Cabin Branch, the nature of which has not been definitely proved, dips at from 45° to 60° and strikes in the northeast and southwest direction,

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[a] Compiled in part from the report of D. H. Newland, Mineral Industry, vol. 16, 1908, p. 841.
[b] Eng. and Min. Jour., January 1, 1910, p. 32.

varying from 6 to 14 feet in thickness and having a horizontal extent, ranging up to 1,000 feet. The single compartment shaft is sunk in the ore, and as a consequence, is rather irregular in grade, thus limiting the speed of hoisting. A depth of approximately 1,500 feet has been reached on the slope, and sinking at the rate of 20 feet per month is still in progress. Near the bottom of the shaft several normal faults were encountered, so that the ore crosses the shaft, being above it at the date of this writing. The ground is fairly good, both walls being of a rather tough slate which stands with little timbering.

Stope methods.—Drifts are run from the shaft in either direction to the end of the ore body at intervals of 100 feet or less. A raise is then driven from the end of each drift to the level above, if it has not caved; or, if the ground above is treacherous or heavy, from 2 to 6 feet of ore are left as a pillar to hold the drift floor above and keep material from coming down upon the men in the stope. This pillar is kept as narrow as the nature of the ground will permit, as it only forms a temporary protection for the men while stoping below it. The raise is carried about 20 feet wide.

After opening up the raise a sort of modified system of retreating-longwall mining is carried on. Beginning at the end of the drift the ore is mined back to within about 30 feet of the shaft in successive strips across the face of the stope from the drift below to the pillar above. One 4-foot or 5-foot hole loaded lightly with 40 per cent dynamite usually suffices to break the ore from foot to hanging. The ore is all mined by contract, and the fact that drill runners, working two men to the drill, using light tripod machines and furnishing their own powder, caps, and light, can earn good living wages breaking the ore at about 20 cents per ton, proves that the mining method is well adapted to the conditions met. By this method of mining probably nine-tenths of the ore is recovered.

The ore runs and is mucked down the stopes and loaded into 1-ton end-dump cars from the floor of the drift. Owing to the steep dip of the foot wall in most places in the mine, the broken lump ore runs freely to the bottom of the stope. The ore makes a comparatively small percentage of fines, which have to be mucked down the stopes. By thus taking advantage of the slope of the ore body, a minimum amount of labor is necessary to deliver ore to the haulage levels.

Timbering.—No timbers are used in the drifts, but stulls or props of Virginia pine are used in the stopes, the usual space between timbers being 6 to 10 feet. No attempt is made to pull these timbers, but the ground is allowed to cave behind the working face as it will. The hanging wall, however, sometimes holds for years. In the steeper stopes some difficulty is experienced from the lump ore knocking out props as it bounds down the foot wall.

The air in the Cabin Branch mine is good and the ventilation almost takes care of itself. For about three-quarters of the way down the incline a ladder and pump way is maintained in the shaft, but in the lower levels this is run through small raises driven in the ore at about 20 feet from the shaft. It is claimed that by carrying these connections between levels in this manner better air circulation is promoted.

Near Mineral, Louisa County, both the Arminius Chemical Company and the Sulphur Mining and Railroad Company operated during the year. At both mines progress was made in development work, and at the Sulphur Mining and Railroad Company's plant, it is planned to install an addition to the mill capacity. At both of these pyrite mines the product is mostly fines. The following notes on the work in progress at the mines located in Louisa County near the close of the year 1909 are taken from the Engineering and Mining Journal:[a]

The Arminius has now reached a depth of 1,060 feet, but the ore body which was 60 feet wide on the 960-foot level has not as yet been cut on the lowest level. Ore is being extracted from the 200-foot, 860-foot, and 960-foot levels and about 400 tons sent to the mill per twenty-four hours. A new shaft 6 feet by 14 feet in the clear is being sunk to the north of the present shaft; it is situated about 50 feet from the ore body in the foot wall, and from it drifts and crosscuts will be run in order to rob the ore which has been left in the stopes.

At the Sulphur Mining and Railway Company's mine work is being pressed on the new vertical 3-compartment shaft which will replace the three inclined ones now used and the necessary underground development to enable the ore body to be worked from the new shaft. Sinking has now reached a depth of 250 feet. To meet the contingen-

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[a] October 30, 1909, p. 890.

cies of the large tonnages a new mill with a capacity of 30 tons per hour will be erected to replace the present one which was designed for 20 tons per hour. It is expected that the new mill will be in operation by the middle of next year. At the present time the output of the mine, as a consequence of the large amount of dead work being carried on, is below normal.

The Boyd-Smith mine is still closed down. * * * This property is situated between the Arminius and the Sulphur companies' mines. It has been idle for about a year. It is reported that the Hemmer heirs intend to open shortly the Julia mine, which is situated about a mile southwest of Mineral. * * * Over in Spottsylvania County John M. Holladay, James B. Elam, and Thomas Jeffress, of Richmond, have a small crew at work developing what is claimed to be a large pyrite ore body.

No production was reported to the Survey from the Spottsylvania County property during 1909.

The Survey has no recent information concerning the Pulaski Mining Company in Pulaski County. The following notice for the year 1908 is taken from Mineral Industry for that year:[a]

The mines are located on the Cripple Creek extension of the Norfolk and Western Railway and the roasting and sulphuric plant is at Pulaski. At the latter plant, pyrrhotite is practically dead roasted. Sulphuric acid is made and the resulting cinder is used as part of the charge in an iron blast furnace. The ore is mined from open cuts; it is crushed and then conveyed to Herreshoff roasters. The cinder from these roasters is then clinkered in a 100-foot rotary cement kiln into which powdered coal is blown at the end opposite the feed. The pyrite cinder, when fed to the kiln, contains from 4 to 7 per cent sulphur; after going through the clinkering process the sulphur content is reduced to 0.05 per cent. The cinder is sold to the Pulaski Iron Company, whose furnace is only a short distance away. About 75 tons of sulphuric acid and 100 tons of iron cinder are being produced daily.

WISCONSIN.

Wisconsin is now producing a small amount of pyrite. The production is reported by the American Zinc Ore Separating Company and the Gribble Mining Company. The pyrite is obtained through separation from zinc blende by electrostatic methods which have been described in a former volume of Mineral Resources.[b]

IMPORTS.

The importation of pyrite still exceeds the domestic supply, as appears from the following table:

Imports of pyrite containing not more than 3.5 per cent of copper, 1905–1909, in long tons.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
1905	511,946	$1,774,379	1908	668,117	$2,624,339
1906	598,078	2,148,558	1909	688,843	2,428,580
1907	627,985	2,581,787			

WORLD'S PRODUCTION OF PYRITE.

In the following table is given the world's production of pyrite and the quantity of pure sulphur which it is supposed to replace in the

[a] Mineral Industry during 1908, p. 787.
[b] Siebenthal, C. E., Mineral Resources U. S. for 1908, pt. 1, U. S. Geol. Survey, 1909, pp. 256–257.

market, estimated on the assumption that the pyrite averages 45 per cent sulphur:

World's production of iron pyrite and quantity of sulphur displaced, 1904–1908, in long tons.

Country.	1904.	1905.	1906.	1907.	1908.
Spain	159,292	176,258	186,262	222,274	259,308
France	267,268	262,907	261,084	278,214	280,233
Portugal [a]	377,540	346,928	345,222	359,413	[b] 80,135
United States	207,081	253,000	261,422	247,387	222,598
German Empire	172,030	182,448	193,869	193,259	216,000
Norway	131,499	159,461	194,770	[b] 232,321	[b] 264,891
Hungary	95,618	105,165	110,849	97,936	97,268
Italy	110,240	115,814	120,437	[b] 124,926	[b] 129,647
Canada	29,499	29,236	35,365	[b] 41,288	[b] 42,264
Newfoundland	60,200	50,720	28,132	19,920	(c)
Russia	(c)	(c)	20,344	21,551	(c)
United Kingdom	10,287	12,186	11,140	10,194	9,448
Bosnia and Herzegovina	10,256	18,745	13,262	7,115	10,238
Belgium	1,058	961	894	391	351
Sweden	15,705	20,435	21,483	26,686	29,103
Total	1,693,492	1,742,686	1,814,210	1,882,875	....
Sulphur displaced [d]	762,071	784,209	816,395	847,294	....

[a] Includes cupreous iron pyrites.
[b] Cupreous iron pyrites.
[c] Statistics not available.
[d] Based on estimated 45 per cent of sulphur content.

THE CONSUMPTION OF SULPHUR IN THE UNITED STATES.

The consumption of sulphur in the United States for the years 1907, 1908, and 1909, in long tons, is given in the following table:

Consumption of sulphur in the United States, 1907–1909, in long tons.

Source.	1907.	1908.	1909.
Domestic sulphur and sulphur content of pyrite	404,430	469,613	350,494
Imported sulphur	22,523	21,136	30,589
Sulphur content of imported pyrite [a]	282,593	300,653	309,979
Total domestic consumption	709,546	791,402	691,062

[a] Based on average sulphur content of 45 per cent.

BARYTES AND STRONTIUM.

By Ernest F. Burchard.

BARYTES.[a]

PRODUCTION.

In 1909 the quantity of crude barytes reported as mined in the United States was 58,377 short tons, valued at $198,561. This value is intended to represent that of the crude barytes at the mines, hand cobbed, sorted, and ready for shipment to the mills. In reality it probably represents, especially for Kentucky, the value of some of the material at railroad shipping points and includes the cost of haulage by wagon.

The production for 1909 showed an increase in quantity of 19,850 short tons and in value of $78,119 over that of 1908, a gain of 51.5 per cent in quantity and of 64.8 per cent in value.

Although the year 1909 showed a very satisfactory gain in the quantity of barytes produced, the record production of 1907 was not reached. Better prices prevailed, however, as the average price of crude barytes per short ton ($3.40) in 1909 was higher than in any previous year. Prices per short ton quoted by wholesale dealers toward the close of 1909 were as follows: "American ground," $12 to $15, and "floated," $17 to $19; "foreign floated," $20 to $23.

The total quantity of barytes reported as refined by mills in Kentucky, Missouri, North Carolina, Tennessee, and Virginia in 1909 was 34,673 short tons, valued at $455,506, an average price per ton at the mills of $13.14, an increase of $1.95 per ton, or 17.4 per cent, as compared with $11.19 per ton in 1908, but considerably below the average price of $14.59 per ton received in 1907. In addition, large quantities of imported barytes were refined by mills in Connecticut and New Jersey.

At the close of 1909 there were 3,376 short tons of crude domestic barytes unsold, according to reports from all the producing districts.

The States that produced crude barytes in 1909 were, in order of their importance, Missouri, Tennessee, North Carolina, Virginia, Kentucky, and Georgia. In Missouri 28 producers reported an output, but in none of the other States were there more than 2 producers, and in some of them only 1 producer reported.

In the production of refined barytes the capacity of the mills that treat domestic materials was far from being fully utilized. Only 2 mills reported production in Missouri and only 1 mill in each of the States of Kentucky, North Carolina, Tennessee, and Virginia.

The following table gives the production of crude barytes in the United States in 1907, 1908, and 1909 by States, and shows the average price per ton at the producing localities:

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[a] Discussions of the character, occurrence, and production of barytes in the United States and Canada will be found in the volumes of Mineral Resources U. S. for 1906 and 1907

Production of crude barytes in the United States, 1907–1909, by States, in short tons.

State.	1907.			1908.			1909.		
	Quantity.	Value.	Average price per ton.	Quantity.	Value.	Average price per ton.	Quantity.	Value.	Average price per ton.
Kentucky	(a)	(a)	....	5,233	$21,504	$4.11	(a)	(a)	....
Missouri	44,039	$162,459	$3.69	16,319	56,768	3.48	34,815	$119,818	$3.44
North Carolina	5,785	18,855	3.26	(a)	(a)	....	(a)	(a)	....
Tennessee	20,861	37,138	1.78	8,618	12,313	1.43	(a)	(a)	....
Virginia	9,254	32,833	3.55	(a)	(a)	....	(a)	(a)	....
Other States	[b] 9,682	40,492	4.18	[b] 8,357	29,857	3.51	[b] 23,562	[b] 78,743	3.34
Total	89,621	291,777	3.26	38,527	120,442	3.13	58,377	198,561	3.40

[a] Included in other States.
[b] Includes, 1907, Georgia and Kentucky; 1908, Georgia, North Carolina, and Virginia; 1909, Georgia, Kentucky, North Carolina, Tennessee, and Virginia.

Production of crude barytes, 1882–1909.

Year	Short tons.	Year	Short tons
1882	22,400	1896	17,068
1883	30,240	1897	26,042
1884	28,000	1898	31,306
1885	16,800	1899	41,894
1886	11,200	1900	67,680
1887	16,800	1901	49,070
1888	22,400	1902	61,668
1889	21,460	1903	50,397
1890	21,911	1904	65,727
1891	31,069	1905	48,235
1892	32,108	1906	50,231
1893	28,970	1907	89,621
1894	23,335	1908	38,527
1895	21,529	1909	58,377

IMPORTS.

The Payne-Aldrich tariff increased the duty on raw barytes imported from foreign countries from 75 cents per long ton to $1.50 per long ton, but on the manufactured material there was no change in the duty of $5.25 per long ton nor on the duty of one-half of 1 cent per pound on the artificial sulphate of barium, or blanc fixe. On witherite, the natural carbonate of barium, which is not known to occur in commercial quantities in the United States, there is no import duty.

The imports of barytes for consumption during the last five years and the imports of barium compounds during the last three years were as follows:

Barytes imported and entered for consumption in the United States, 1905–1909, in short tons.

Year.	Manufactured.		Unmanufactured.	
	Quantity.	Value.	Quantity.	Value.
1905	4,803	$39,803	14,256	$62,459
1906	4,807	37,296	9,190	27,584
1907	11,207	96,542	20,544	76,883
1908	3,401	29,168	13,661	58,822
1909	3,016	25,679	11,647	29,028

Value of the imports of barium compounds, 1907–1909.

Barium compound.	1907.	1908.	1909.
Witherite, barium carbonate	$24,552	$22,159	$31,584
Barium binoxide	167,519	181,533	255,013
Barium chloride	79,333	42,291	47,352
Blanc fixe, or artificial barium sulphate	85,713	73,131	65,427
	357,117	319,114	399,376

PRODUCTION OF BARYTES IN CANADA.

According to the preliminary report on the mineral production of Canada in 1909 there were produced in that year 4,119 short tons of barytes, valued at $29,213. This is a small decrease in quantity, but a large increase in value as compared with the production of 1908, which, according to the revised statistics, was 4,312 tons, valued at $19,021.

BARYTES AS A PIGMENT.[a]

One of the principal uses of barytes is as a pigment in mixed paints. It is used in the finely ground, bleached, and floated condition and is a constituent of lithopone. Barytes and blanc fixe (artificial barium sulphate) belong to the class of pigments called inert extenders and reenforcing pigments, along with such other minerals as gypsum, whiting, asbestine, and silica. In the past the overloading of mixed paints with inert pigments has been the main cause of a strong prejudice that has grown in the minds of consumers against the use of such pigments. So-called "pure paint laws" have been enacted in certain States, making it compulsory for paint manufacturers to label all paint packages with the formula of the contents. In connection with this movement toward paint legislation the thorough testing of mixed paints has been carried on during the last four years by the Paint Manufacturers' Association of the United States. The results have been of great practical value to paint manufacturers and consumers, and have afforded a reliable means of comparing the merits of various mixtures of pigments for the information of legislators who are called upon to regulate the labeling and selling of paints. After very thorough laboratory tests and exposure tests under various climatic conditions such as at Atlantic City, N. J., Pittsburg, Pa., and Fargo, N. Dak., a committee representing the Master Painters' Association of Philadelphia and the scientific section of the Paint Manufacturers' Association of the United States, have arrived at very definite conclusions with regard to the value and limitations of the use of barytes and other inert pigments in mixed paints. This committee considers that these materials have no especial value as pigments when used alone, but that their intelligent use within certain limits is necessary for the production of a satisfactory mixed paint. Specifically, it states that it has been established by the tests that the use of such pigments in quantities up to 15 per cent is thoroughly justified and results in better paints; and therefore the committee recommends to architects and master painters of the United States for the painting of general exterior

[a] For a more complete discussion of paint tests, see chapters on mineral paints, in Mineral Resources U. S. for 1907, 1908, and 1909, and bulletins of the Paint Manufacturers' Association. The Survey assumes no responsibility for any of the conclusions reported here.

woodwork mixtures of the white leads and zinc oxides with crystalline pigments such as barytes, asbestine, silica, and calcium carbonate, wherein the inert pigments do not exceed 15 per cent by weight of the total mixture. The use of a mixture of barytes and blanc fixe, which are physically different but chemically the same, permits advantage to be taken of the difference in size of the particles exhibited by the two minerals. This advantage finds its application through the fundamental principle regarding paint films, that a paint coating consisting of three sizes of particles is superior to a film containing only one or two sizes of particles.

The investigations that have demonstrated the legitimate place of barytes products among pigments have helped to restore confidence in these materials, and it is expected that the depression in the trade caused partly through misuse of the materials by paint manufacturers and partly through misapprehensions on the part of consumers will soon be overcome.

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STRONTIUM.

No strontium ore is reported to have been produced in the United States in 1909. The only importation of strontium salts reported by the Bureau of Statistics in 1909 was strontium monoxide or strontia, valued at $270.

MINERAL PAINTS.

By Ernest F. Burchard.

NATURAL MINERAL PAINTS.

NATURAL PIGMENTS.

Production.—In 1909 the total production of the natural pigments—ocher, umber, sienna, metallic paints, mortar colors, slate, and shale—reported to the Survey amounted to 61,137 short tons, valued at $613,133, as compared with 49,853 short tons, valued at $536,544, in 1908, an increase of 11,284 short tons in quantity and of $76,589 in value. The following table shows the production of these several natural mineral pigments from 1906 to 1909, inclusive.

This comparatively large increase was confined, as is shown in the following table, to the metallic paint, mortar color, and shale pigments.

Production of natural mineral pigments, 1906–1909, in short tons.

Kind.	1906.		1907.		1908.		1909.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Ocher	15,482	$148,049	16,971	$164,742	17,019	$156,360	14,310	$137,880
Umber, Sienna	657	17,394	730	19,309	2,756	70,996	1,546	43,872
Metallic paint	17,992	204,026	16,225	195,176	16,224	182,007	25,414	256,373
Mortar colors	10,309	111,720	10,490	110,719	9,026	86,961	11,620	116,126
Slate and shale, ground	5,481	40,540	4,130	40,540	4,828	40,220	8,247	58,882
Total	49,921	521,729	48,546	530,486	49,853	536,544	61,137	613,133

OCHER, UMBER, AND SIENNA.

PRODUCTION.

Ocher.—The quantity of ocher reported to the Survey as having been mined in the United States in 1909 was 14,310 short tons, valued at $137,880; in 1908 there were reported as produced 17,019 short tons, valued at $156,360, a decrease in 1909 of 2,709 short tons in quantity and of $18,480 in value. The relative rank of the States as producers remains practically the same as in 1908. Aside from the demand for ocher in the paint trade, there is generally a good market for it in the manufacture of oilcloths and linoleums, a large proportion of the production of this mineral from Georgia, Pennsylvania, and Vermont now being taken by makers of these fabrics.

Umber and sienna.—The combined production of umber and sienna in 1909 amounted to 1,546 short tons, valued at $43,872, as compared with 2,756 short tons, valued at $70,996, in 1908. The production of these substances, therefore, shows a decrease for the year of 1,210 tons in quantity and $27,124 in value.

The production of ocher by States for the last four years is shown in the following table:

Production of ocher, 1906–1909, by States, in short tons.

State.	1906.		1907.		1908.		1909.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
California	500	$4,470	450	$3,970	335	$2,250	(a)	(a)
Georgia	5,550	58,350	5,600	57,100	6,035	63,851	5,838	$60,971
Pennsylvania	8,597	79,244	8,047	76,816	9,286	78,956	5,989	58,003
Vermont	(a)	(a)	682	6,638	188	2,050	492	4,726
Other States	b 835	5,985	b 2,192	20,218	b 1,175	9,253	b 1,991	14,180
Total	15,482	148,049	16,971	164,742	17,019	156,360	14,310	137,880

a Included in "Other States."
b Includes, 1906, Alabama, Iowa, Kentucky, Vermont, and Virginia; 1907 and 1908, Iowa, Kentucky, and Virginia; 1909, California, Iowa, and Virginia.

The total production of ocher and of umber and sienna in the United States from 1905 to 1909, inclusive, is as follows:

Production of ocher and of umber and sienna, 1905–1909, in short tons.

Year.	Ocher.		Umber and sienna.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1905	13,402	$126,351	689	$17,004	14,091	$143,355
1906	15,482	148,049	657	17,394	16,139	165,443
1907	16,971	164,742	730	19,309	17,701	184,051
1908	17,019	156,360	2,756	70,996	19,775	227,356
1909	15,430	141,246	1,546	43,872	15,826	181,752

IMPORTS.

The imports of ocher, umber, and sienna for the last five years are shown in the following tables:

Imports of ocher, 1905–1909, in pounds.

Year.	Crude.		Dry.		Ground in oil.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1905			10,616,496	$91,673	15,985	$880	10,632,481	$92,553
1906			11,316,868	97,830	113,049	2,233	11,429,917	100,063
1907	127,117	$1,312	11,850,372	102,194	14,482	1,079	11,991,971	104,585
1908	584,129	4,954	8,663,537	69,815	6,094	307	9,253,760	75,076
1909	340,593	3,501	13,337,310	106,224	17,847	939	13,695,750	110,664

Imports of umber, 1905–1909, in pounds.

Year.	Dry.		Ground in oil.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1905	2,580,501	$20,763	6,783	$461	2,587,284	$21,224
1906	2,948,539	23,732	6,028	418	2,954,567	24,150
1907	3,395,690	26,502	2,569	211	3,398,259	26,713
1908	2,391,153	19,461	15,556	803	2,406,709	20,264
1909	3,104,037	26,125	4,953	256	3,108,990	26,381

Imports of sienna, 1905–1909, in pounds.

Year.	Dry.		Ground in oil.		Total.	
	Quantity.	Value.	Quantity,	Value.	Quantity.	Value.
1905	1,737,909	$26,097	2,886	$227	1,740,795	$26,324
1906	1,941,664	32,673			1,941,664	32,673
1907	2,176,566	34,752	14,629	864	2,191,195	35,616
1908	1,756,273	28,407	7,621	458	1,763,894	28,865
1909	2,402,901	32,913	6,114	421	2,409,015	33,334

WORLD'S PRODUCTION OF OCHER.

The following table gives the output of ocher in the principal producing countries for the years 1904 to 1908, inclusive, as far as statistics are available:

World's production of ocher, 1904–1908, in short tons.

Year.	United States.		United Kingdom.		France.		German Empire.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1904	16,826	$110,602	17,976	$88,656	38,520	$639,192	21,062	$26,280
1905	13,402	126,351	18,185	75,238	41,667	655,003	20,175	40,369
1906	15,482	148,049	15,915	71,358	39,187	275,266	24,586	72,920
1907	16,971	164,742	16,455	70,117	36,217	423,830	1,679	5,290
1908	17,019	156,360			36,442	457,072		

Year.	Canada.		Belgium.		Japan.		Cyprus.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1904	3,925	$24,995	496	$1,592	192	$764	a 2,540	$5,531
1905	5,105	34,675	683	2,084	23	243	a 3,092	6,817
1906	6,837	36,955	276	243	32	297	a 2,526	6,258
1907	5,828	35,569	220	876	331	2,531	a 7,301	20,279
1908	4,746	30,440						

a Umber exports.

METALLIC PAINT AND MORTAR COLORS.

PRODUCTION.

Metallic paint and mortar colors are red and brown iron oxides, produced either by grinding the mineral found in the natural state, or by roasting iron carbonate. The production of metallic paint and mortar colors in 1909, as reported to the Survey, amounted to 37,034 short tons, valued at $372,499, a large increase in quantity over the 1908 production, which was 25,250 short tons, and also a large increase in value as compared with $268,968, the total value for 1908. Pennsylvania still continues to produce the largest quantity of metallic paint. New York is the next largest producer, and the other States maintain practically the same rank as in 1908. The following table gives the production of metallic paint and mortar colors from 1906 to 1909, inclusive:

Production of metallic paint and mortar colors, 1906–1909, by States, in short tons.

State.	1906.		1907.		1908.		1909.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity	Value.
Maryland and Tennessee	5,625	$51,800	6,038	$64,020	4,919	$47,403	5,963	$48,902
New York	7,106	79,060	6,394	70,771	7,048	65,482	8,244	79,072
Ohio	[a] 1,929	19,360	[a] 1,341	15,471	[a] 1,171	10,546	[a] 1,515	17,145
Pennsylvania	11,021	136,086	10,327	127,973	9,197	113,112	[b] 16,174	196,067
Other States	[c] 2,620	29,440	[c] 2,615	27,660	[c] 2,915	32,425	[c] 5,138	31,313
Total	28,301	315,746	26,715	305,895	25,250	268,968	37,034	372,499

[a] Includes 1906 and 1908, Connecticut and Vermont; 1907 and 1909, Connecticut.
[b] Includes a small quantity of Venetian red.
[c] Includes 1906 and 1907, California, Illinois, and Wisconsin; 1908, California, Virginia, and Wisconsin; 1909, California, Michigan, Vermont, Washington, and Wisconsin.

SLATE AND SHALE.

PRODUCTION.

Slate and shale were ground for use as pigments in 1909 in Pennsylvania, New Jersey, New York, and Iowa, the first two States being the principal producers. In 1909 there were reported to the Survey 8,247 short tons, valued at $58,882. This is an increase in quantity of 3,419 short tons, and in value of $18,662.

The following table gives the production of slate and shale ground for pigment from 1906 to 1909, inclusive:

Quantity and value of slate and shale ground for pigment, 1906–1909.

1906	short tons	5,481	$40,540
1907	do	4,130	40,540
1908	short tons	4,828	$40,220
1909	do	8,247	58,882

PIGMENTS MADE DIRECTLY FROM ORES.

The important pigments made directly from ores of valuable metals are zinc oxide, leaded zinc oxide, zinc-lead, sublimed white lead, and sublimed blue lead. The ores utilized in making these pigments are the franklinite ores of New Jersey, the sphalerite and galena ores of the Mississippi Valley (mined in the Platteville district of Wisconsin and the Joplin district of Missouri, Kansas, and Oklahoma), and the sulphide, carbonate, and silicate ores of zinc and lead produced in Colorado and New Mexico.

PRODUCTION.

Zinc oxide.—The production of zinc oxide in 1909 as reported to the Survey was 68,974 short tons, valued at $6,156,755, as compared with 56,292 short tons, valued at $5,072,460, in 1908. This represents an increase of 12,682 short tons in quantity and of $1,084,295 in value. The reported average value per ton in 1908 was $90.11; that of 1909 was $89.26, a decline of 85 cents per ton.

Zinc-lead.—The production of zinc-lead, including leaded zinc oxide, in 1909 was 7,655 short tons, valued at $634,714, as compared with 8,430 short tons, valued at $778,200, in 1908, a decrease of 775 short tons in quantity and of $143,486 in value. In 1908 the average value per ton was $92.31; in 1909 it was $82.91, a fall of $9.40 per ton.

Sublimed white lead.—In 1909 there were produced in the United States 9,915 short tons of sublimed white lead, valued at $1,070,820, an average value of $108 per ton; in 1908 the production amounted to 9,100 short tons, valued at $973,700, an average value of $107 per ton. There was, therefore, an increase in quantity in 1909, as compared with 1908, of 815 short tons and an increase in value of $97,120. The increase in value per ton in 1909 as compared with 1908 was $1, or less than 1 per cent of the average value per ton in 1908.

Sublimed blue lead.—There were 981 short tons of sublimed blue lead produced in 1909, valued at $101,043, as compared with 1,311 short tons, valued at $121,923, in 1908—a decrease of 330 tons in quantity and of $20,880 in value. The average value per ton in 1908 was $93; in 1909 it was $103, a rise of $10 per ton, or over 10 per cent of the value per ton in 1908. The following table shows the production of pigments made directly from ores from 1906 to 1909, inclusive:

Production of pigments made directly from ores in short tons.

Pigment.	1906.		1907.		1908.		1909.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Sublimed blue lead	....	....	1,211	$135,632	1,311	$121,923	981	$101,043
Sublimed white lead	7,988	$958,440	8,700	1,026,600	9,100	973,700	9,915	1,070,820
Zinc-lead	8,124	681,292	13,516	1,286,440	[a] 8,430	778,200	[a] 7,655	634,714
Zinc oxide	74,680	5,999,375	71,784	6,490,660	[b] 56,292	5,072,460	68,974	6,156,755
Total	90,792	7,639,107	95,211	8,939,332	75,133	6,946,283	87,525	7,963,332

[a] Includes leaded zinc oxide. [b] Exclusive of 945 tons from foreign ores.

IMPORTS.

The following table shows the imports of zinc oxide into the United States in the last five years:

Imports for consumption of zinc oxide, 1905–1909, in pounds.

Year.	Dry.		In oil.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1905	3,436,367	$196,220	342,944	$40,542	3,779,311	$236,762
1906	4,191,476	251,609	292,538	36,457	4,484,014	288,066
1907	5,311,318	323,551	362,814	33,679	5,674,132	357,230
1908	4,635,101	262,876	210,166	16,798	4,845,267	279,674
1909	6,119,328	342,999	535,024	54,085	6,654,352	397,084

CHEMICALLY MANUFACTURED PIGMENTS.

Under this heading are grouped the important lead pigments made from pig lead and lead compounds, and such minor pigments as lithopone and Venetian red, both of which are chemically precipitated from mineral salts. Much of the material now sold as Venetian red, however, instead of being precipitated from ferrous sulphate and calcium hydroxide, is made in several ways, such as by calcining both pyrites and a mixture of ferrous sulphate and terra alba, and also by grinding natural red iron oxide with a white base, such as ground oyster shells.

PRODUCTION.

The total production of this group of pigments increased in quantity from 182,364 short tons in 1908 to 211,687 short tons in 1909, and in value from $20,708,940 in 1908 to $24,253,620 in 1909.

Basic carbonate white lead.—The production of basic carbonate (corroded) white lead in 1909, as reported to the Survey, was 148,099 short tons, valued at $18,205,082. This includes white leads produced by both the Dutch process and the mild process. Of this total, 115,259 short tons, valued at $14,736,360, were sold in oil, and 32,840 short tons, valued at $3,468,722, were reported sold dry. The sales for 1909 represented a net gain over those for 1908 of 15,511 short tons in quantity, and of $2,313,481 in value, showing a general increase in the average value per ton from $119.85, in 1908, to $122.93, in 1909, of $3.08 per ton, or about 2.6 per cent of the value per ton in 1908.

Red lead.—The production of red lead rose from 16,720 short tons, valued at $2,065,202, in 1908, to 19,103 short tons, valued at $2,335,799, in 1909, an increase of 2,383 short tons in quantity and of $270,597 in value. The average value per ton fell from $123.52 in 1908 to $122.27 in 1909, a decrease of $1.25 per ton, or 1.01 per cent, of the value per ton in 1908.

Litharge.—In 1909 litharge was produced to the extent of 20,690 short tons, valued at $2,363,002, as compared with 15,542 short tons, valued at $1,887,506, in 1908, an increase of 5,148 short tons in quantity and of $475,496 in value. This represents a fall from the average value per ton of $121.45 in 1908 to $114.21 in 1909, a decrease of $7.24, or about 6 per cent of the value per ton in 1908.

Orange mineral.—Orange mineral likewise showed an increase in output, there being produced in 1909, 590 short tons, valued at $98,723, as compared with 397 short tons, valued at $65,498, in 1908, an increase of 193 short tons in quantity and of $33,225 in value. The apparent average value in 1908 was $164.98, and in 1909 it was $167.33, or a rise of $2.35 per short ton in 1909.

Lithopone.—The production of lithopone in 1909 was reported as 14,847 short tons, valued at $1,105,281, as compared with 8,292 short tons, valued at $639,483, in 1908. This represents an increase of 6,555 short tons in quantity and of $465,798 in value. In the case of lithopone the value per ton apparently fell from $77.12 in 1908 to $74.44 in 1909, or $2.68 per ton, which represents about 3.5 per cent of the value per ton in 1908.

Venetian red.—The production of Venetian red in 1909 amounted to 8,358 short tons, valued at $145,733, as compared with 8,825 short tons, valued at $159,650, in 1908. This represents a decrease of 467 short tons in quantity and of $13,917 in value. The average value per ton apparently decreased from $18.09 in 1908 to $17.44 in 1909, or 65 cents.

The following table gives the production of these various chemical pigments and colors for the years 1906 to 1909, inclusive:

Production of chemically manufactured pigments, 1906–1909, in short tons.

	1906.		1907.		1908.		1909.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Basic carbonate white lead:								
In oil	93,763	$12,357,632	92,216	$12,138,932	101,109	$12,552,771	115,259	$14,736,360
Dry	38,318	4,571,618	35,035	4,309,392	31,479	3,338,830	32,840	3,468,722
Red lead	13,808	1,924,288	20,078	2,802,454	16,720	2,065,202	[a]19,103	2,335,799
Litharge Orange mineral	}18,910	2,551,346	20,838	2,854,987	15,542	1,887,506	20,690	2,363,002
			669	129,410	397	65,498	590	98,723
Lithopone	4,300	311,500	10,275	750,350	8,292	639,483	14,847	1,105,281
Venetian red	13,526	198,394	7,566	134,167	8,825	159,650	8,358	145,733
Total	182,625	21,914,778	186,677	23,119,692	182,364	20,708,940	211,687	24,253,620

[a] Includes small quantity of orange mineral.

IMPORTS.

The following table gives the quantity and value of the imports of corroded white lead, red lead, litharge, orange mineral, and Venetian red from 1905 to 1909, inclusive:

Basic carbonate white lead, red lead, litharge, orange mineral, and Venetian red imported, 1905–1909, in pounds.

Year.	Corroded white lead.		Red lead.		Litharge.		Orange mineral.		Venetian red.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1905	597,510	$34,722	704,402	$26,553	117,757	$4,139	628,003	$31,106	4,558,998	$39,585
1906	647,636	41,233	1,093,639	50,741	87,230	3,737	770,342	42,519	5,432,732	43,091
1907	584,310	37,482	679,171	35,959	90,475	4,386	615,015	37,793	4,738,148	37,869
1908	540,311	30,452	645,073	28,155	96,184	3,327	485,407	26,645	3,113,858	25,745
1909	694,599	39,963	760,179	30,428	90,655	3,740	496,231	27,562	3,999,560	28,864

OUTLOOK FOR PAINT MANUFACTURE.

Mr. G. B. Heckel, secretary of the Paint Manufacturers' Association of the United States, is so closely in touch with recent developments in paint manufacturing and so clearly expresses their relations to future conditions, that an extract from a recent article by him is of interest.[a]

The paint-manufacturing industry is one of the few important fields of enterprise which still remain comparatively free from the tendency toward combination and consolidation; consequently the distress attendant upon the recent business depression was more widely distributed, but less acute in this than in some other fields.

[a] Heckel, G. B., The outlook for paint manufacture: Annals Am. Acad. Polit. Soc. Sci., November, 1909.

The paint trade enjoyed a distinct advantage from the fact that while the manufacturing, commercial, and financial institutions of the country were seriously embarrassed by loss of confidence and shortage of funds, the rural populace, especially in agricultural communities, were at no time seriously incommoded, one good crop year having succeeded another, so that the "panic" scarcely affected the country districts at all, except sentimentally. This condition, coupled with the extraordinary selling efforts put forth by the trade, maintained the consumption of what are technically known as "shelf goods" at nearly the average normal volume. In structural, railway, manufacturing, and technical lines, the condition was, of course, reversed, consumption falling to the minimum, and the competition for such trade as was offered cutting away all possible margin of profit.

The annual consumption of paints and varnishes of all kinds in the United States certainly exceeds $200,000,000, the three items of white lead, zinc oxide, and linseed oil alone amounting to nearly $40,000,000 of the total. Roughly speaking, this consumption is about equally divided between what may be called house-painting products and technical products (railway and bridge paints, wagon, and implement paints, etc.). We may, therefore, estimate pretty closely, that during the two years of depression, paint consumption was reduced by about one-half, the reduction in the first classification being about balanced by the remaining demand in the second.

Such a condition naturally involved some expert financiering, a reduction of forces to the minimum, and the enforcement of rigid economy all along the line. That practically the entire industry weathered the storm speaks volumes for the business sagacity and ability of those engaged in it. Recovery has been gradual but persistent. The demand in house-painting goods had reached the normal volume nearly a year ago, and in manufacturing and structural goods there now is almost complete recovery.

The demand in the car-building and railroad department has, however, lagged behind. In fact it is only at this writing that these lines give evidence of recovery. Recovery in this particular industry is significant. According to the late Dr. C. B. Dudley, the Pennsylvania Railroad alone in 1906 consumed annually nearly a million dollars' worth of paints. According to Poor's Manual, the Pennsylvania Railroad operates about one-fifteenth of the railroad equipment of the country, while its mileage is less than one-thirtieth the total. Allowing for the high grade of maintenance characterizing this road, we shall perhaps be conservative in estimating the total railway consumption of the country at $12,000,000 to $15,000,000 annually. The addition or subtraction of this consumption naturally means much to those houses that cater to it.

But we have further to consider the fact that during more than two years past, this consumption has been limited on the basis of "rigid economy," and that now not only must the railways add their normal annual equipment, but they must also add the new equipment deferred for two years, besides providing for the repairs and renewals deferred during the same period. We may, therefore, expect that the railways during the coming year will be forced to distribute between $20,000,000 and $30,000,000 among paint and varnish manufacturers.

Large construction also has lagged notoriously during and since the fall of 1907, but a vast revival is already apparent in this department. Here, again, we shall find, along with the construction of normal times, an important increment from deferred operations. In this field then we may also anticipate an extraordinary demand during 1910. These are but concrete examples of what is to be anticipated from the entire field of paint consumption.

The paint manufacturing industry as a whole has advanced rapidly during the last ten years, the temporary setback of 1907 being but an incident. This is particularly true of the prepared-paint industry, including in the term "prepared paint" all those products in which the materials are prepared practically ready for use by mechanical means, in contradistinction to those products which the consumer must temper and combine for use. During the decade under consideration there has been a general reconstruction of factories along modern lines of mechanical efficiency and operating economy. Wood construction has been widely replaced by concrete or slow-combustion millwork, and electrical distribution of power has in many places superseded distribution through shafting and belting.

Side by side with this advance in mechanical efficiency has proceeded an interesting technical development, of which the end is not yet in sight. The trained chemist and physical investigator has risen in authority over the old inherited "formula book," or the private "notebook" of the shifting factory superintendent. This vital change has been reflected in increased efficiency, both at the buying and the selling end; the raw materials being bought and inspected according to chemical and physical standards, and formulas being revised to fit discovered facts of service, rather than the reverse.

Consolidation, as has been remarked, has made but little headway in the paint trade, yet the modern cooperative spirit has made its way here as elsewhere. This spirit is manifested not only in the social, financial, and industrial betterment schemes operative in many of the larger plants, but also in the cooperative work maintained in the bureau of promotion and development of the Paint Manufacturers' Association. This bureau not only carries on systematic educational work among paint dealers, but also, in its "scientific section," maintains a well-equipped laboratory for technical experiment and research, the results of which are regularly placed at the disposal of all the members. The bureau furthermore, in cooperation with various technical bodies—the North Dakota Agricultural College, the American Society for Testing Materials, the Geological Survey, the Bureau of Roads, etc.—has erected and maintains wood and steel test fences at various points, to test on a large scale and under known conditions the action of the various pigments, vehicles, and formulas.

To illustrate the significance and importance of this work, let us consider briefly the steel test fences at Atlantic City and Pittsburg. Some three years since, Dr. Allerton S. Cushman, of the United States Department of Agriculture, and Dr. Percy H. Walker, one of his colleagues, in investigating the corrosion of steel fence wire and steel highway culverts, became convinced that some commonly used paint materials promote, while others prevent or, to use Doctor Cushman's lucid term, "inhibit" corrosion. Doctors Cushman and Walker communicated their observations to the American Society for Testing Materials and the Department of Agriculture issued a bulletin on the subject.

The bureau of promotion and development, realizing the importance of the matter to the paint trade, then came forward and proposed to erect, under the supervision of the American Society for Testing Materials, a steel plate fence at Atlantic City and a steel wire fence at Pittsburg, where these conclusions could be given a comprehensive field test. The results thus far seem to justify the conclusion that corrosion in steel structures is ordinarily caused by electrolysis to conduct the currents set up in the steel itself; that some pigments and vehicles promote such corrosion by acting as electrolytes to conduct the current; and that others inhibit such corrosion by rendering the steel surface "passive" or incapable of electrolytic corrosion. The final confirmation of these apparent facts and their practical application in the industry will mean much, not only to the farmers who use fence wire and the railway and other interests which utilize vast quantities of steel materials, but also to the natural resources of the country—for iron ore is an exhaustible commodity, which, as has been pointed out, when once gone can never be renewed.

The wooden fences referred to are maintained for similar purposes and have already thrown much light upon the causes for the deterioration of paint and the means to be adopted for preventing or deferring it. One very important conclusion already officially promulgated as a result of these tests is the maxim that "a mixture of two or more of the prime white pigments (white lead, oxide of zinc, sublimed white lead, etc.) when used alone or in combination with a small percentage of inert pigments (barytes, silica, silicate of aluminum, silicate of magnesium, etc.) makes a paint far superior to that made from one pigment alone."

In conclusion, the paint industry of the country is, at this writing, in a healthy and prosperous condition, with an inspiring outlook in the near future.

PAINT TESTS.

The study of protective coatings for structural materials has been actively continued during the year 1909. Since the publication of the report on mineral paints for 1908 there have been added to date (June, 1910) nine bulletins by the scientific section of the Paint Manufacturers' Association of the United States under the directorship of Henry A. Gardner, of Philadelphia, and others are in preparation. These bulletins are listed in the bibliography at the end of this paper. The scope of testing work included paints for wood, for metals, and for concrete. The principal investigations have been carried on as usual by the scientific section at its chemical laboratories in Philadelphia, and at its test fences in Atlantic City, N. J., Pittsburg, Pa., and Fargo, N. Dak.

ATLANTIC CITY TESTS.

The second annual inspection of the paints applied to the Atlantic City wooden test fence was made on May 10, 1910, by a committee representing the Master Painters' Association of Philadelphia, and the scientific section of the Paint Manufacturers' Association of the United States. The following summaries of results and conclusions represent the findings of the above committee as published by the Paint Manufacturers' Association. The Survey assumes no responsibility for any of the statements, but presents them as representing the results of the most practical testing work that has been carried on.

General conclusions.—The white lead paints on the fence showed in every instance a rough, chalked, and disintegrated surface that seemed to be well worn, in some cases nearly to the wood. The strongly oxidizing air of the seacoast is probably responsible for the early decay of this pigment. The committee finds that the addition of 40 to 50 per cent of zinc oxide to white lead increases its durability and retards its chalking, renders it whiter, and forms a much better repainting surface. The combinations of white lead and zinc oxide on this fence were in general good condition throughout.

Corroded white lead, sublimed white lead, zinc oxide, and zinc-lead are regarded by the committee as the standard white opaque pigments. They were all tested on the Atlantic City fence, and it was found that the use of any one of them alone resulted in inferior protection to the wood. Barium sulphate, silica, asbestine, and calcium carbonate are the standard crystalline or inert pigments. The addition of not more than 15 per cent of these inert pigments to any of the standard opaque white pigments, such as white lead or zinc oxide, apparently results in better surface. Some of the best preserved painted surfaces on the fence were those of paints composed of ingredients mixed as stated.

In the past the overloading of mixed paints with crystalline or inert pigments has been the main cause of the prejudice that painters have had against the use of such pigments. The committee considers that it has been established by these tests that the use of these pigments in quantities up to 15 per cent is thoroughly justified and results in better paints, and therefore the committee recommends to architects and master painters of the United States for the painting of general exterior woodwork mixtures of the white leads and zinc oxides with crystalline pigments such as barytes, asbestine, silica, and calcium carbonate, wherein the inert pigments do not exceed 15 per cent by weight of the total mixture.

PITTSBURG TESTS.

The fence erected for testing paints at Pittsburg, Pa., is located on the grounds of the Carnegie Technical Schools. The first test was made on 560 panels of wood consisting of white pine, yellow pine, and cypress. After the application of the paints the panels were exposed for about thirteen months prior to the first annual inspection, which was held May 4, 1909, and a second annual inspection was made May 7, 1910. The plain colors applied were white, yellow, and gray, and the special colors were bronze green, chrome green, ultramarine blue, Prussian blue, and Para red. In the vicinity of Pittsburg large volumes of sulphurous and carbonic acid gas, besides much soot, are poured into the air day and night. The humidity is comparatively high in this locality, and the extremes of temperature are fairly great, so that climatic and atmospheric conditions may be said to be rather severe on paints, and the tests afford valuable suggestions as to what kinds of paint may or may not be capable of withstanding these conditions. It was found that the white pine panels made the best base on which to test the comparative wearing of the paints, and afforded no unfair conditions such as other woods might offer to interfere with the tests. The general conclusions that have been drawn from the Pittsburg tests are as follows:[a]

Mixed paints.—As in the Atlantic City paint tests,[b] the results of the inspection of the Pittsburg tests showed conclusively that mixtures containing more than one standard opaque white pigment, whether alone or in combination with not more than 15 per cent of crystalline, inert pigments, produce paints that are far superior to paints manufactured from one pigment alone. This result is shown particularly in reference to the wearing qualities of the paints.

White lead.—The pure, basic carbonate white lead, or straight white lead panels deteriorated badly through checking, chalking, and discoloration. The discoloration occurs as a black and gray film, caused by alteration of the white coat by the action of sulphur gases, which produce black sulphide of lead. The softness of this pigment and its roughness may have caused adherence of particles of soot, which contributed also to the darkened appearance. Although basic carbonate white lead, when used alone, proved to be unsuitable as a paint in the Pittsburg district, yet when mixed with other suitable pigments a high percentage of white lead in a paint formula showed excellent results.

Sublimed white lead.—Basic sulphate white lead chalked and disintegrated badly, but did not check or discolor. Moreover, the deterioration required several months longer for its accomplishment than that of the basic carbonate white leads. The sublimed white lead maintained good white color on account of its inertness in the presence of sulphur gases.

Zinc-lead.—The zinc-lead panel became rather dark-grayish in color, but was in other respects in fairly good condition.

Zinc oxide.—The paint composed wholly of zinc oxide was shattered badly, showing considerable scaling, and the result indicated that the brittle nature of zinc oxide films requires the addition of white lead.

Lithopone.—Paints containing large percentages of lithopone failed rapidly on the Pittsburg fence. It has been suggested that much better paints containing lithopone might be made by using a less penetrable vehicle made somewhat in the nature of a varnish. Zinc oxide and calcium carbonate are also beneficial in admixture with lithopone in preventing its early chalking and surface decay.

Tinted paints.—The gray paints which contained little or no basic carbonate white lead were superior in maintenance of tone, tint, and general condition to any of the other grays. Some of the grays which showed to the best advantage contained mineral colors, such

[a] Bull. Sci. Sec. Paint Mfrs. Assoc. No. 17, 1909, pp. 15-19, and unpublished data.

[b] Bull. Sci. Sec. Paint Mfrs. Assoc. No. 16, 1909, pp. 20-24. Also the production of mineral paints, Mineral Resources U. S. for 1908, U. S. Geol. Survey, 1909, pp. 691-693.

as umber, ocher, and iron oxide. The formulas containing basic carbonate white lead tinted with lamp black showed good permanence of color.

The value of zinc chromate and lead chromate and ocher in giving yellow tints, much more permanent in wearing properties than the whites, was demonstrated. This was true with single pigments as well as with composite type paint.

Special colors.—The panels on which paints colored by Para reds were applied were found in better condition than those exposed an equal length of time at Atlantic City. This may be accounted for by the fact that Para red is manufactured by precipitation in an acid solution, therefore its color is best maintained under acid conditions. The acidity of the Pittsburg atmosphere, caused by the large quantities of acid gases which are being poured into the air and are continually condensing on the surfaces of structures, may account for the better preservation of these reds. As at Atlantic City, the Para reds which were applied to panels prime-coated with basic carbonate white lead seemed to be brightening in color. The final result appears to be a pinkish tint.

The comparison between the effect of the Atlantic City climate and that of Pittsburg on the green paints is of interest. As a rule there was no mildewing in Pittsburg, while in the atmosphere of Philadelphia and Atlantic City this is a very common fault of the greens. Both bronze green and chrome green stood the first year's test in Pittsburg exceedingly well.

Of the blue paints those that faded the least and wore the best were applied in combination with either sublimed white lead (basic sulphate white lead) or with zinc oxide, while those blues which were applied in combination with basic carbonate white lead showed marked failure and were completely bleached. The bleaching was due to the action of the alkalinity of the white lead on Prussian blue, forming a white compound. It was shown that the mixed leads or graded leads, which are combinations of white leads with other high grade pigments and contain some inert pigments, deteriorated far less rapidly than did the straight white leads. The high-grade composite formulas showed great superiority to the strictly white lead paints, and also to the graded leads that contained a high percentage of inert pigments.

NORTH DAKOTA TESTS.

Three test fences were built in North Dakota on the grounds of the State Experiment Station in 1906, 1907, and 1908, respectively. An inspection of these fences was made in November, 1909, by a committee representing the Paint Manufacturers' Association of the United States. The detailed results of the inspection of this fence have been published.[a]

Mixed paints.—Higher types of pigments containing mixtures of white lead and zinc oxide, with moderate percentages (as high as 15 per cent) of inert reinforcing crystalline pigments, such as asbestine, barytes, silica, and calcium carbonate, on good wood were in most excellent general condition. They were much superior to the single pigment paints and showed better wear than paints made from white lead and zinc oxide without any inert pigments.

[a] Bull. Sci. Sec. Paint Mfrs. Assoc. No. 25, 1910.

White lead.—The white leads painted out on the 1908 fence exhibited different degrees of checking; the mild process lead and the sublimed white lead, which presented the best surfaces, were free from checking, while the old process leads showed very deep and marked checking even after one year's wear. It was the opinion of the committee that in such climates as that of North Dakota white lead alone is not entirely satisfactory as a paint coating.

Sublimed white lead.—The basic sulphate white lead was found in fair condition with very little checking, and with a fair repainting surface.

Tinted paints.—The colored formulas in all cases showed great superiority over the same paints in white, and demonstrated that a small percentage of color has a wonderful influence on the preservation of the paint coating by tending to prevent chalking, checking, and general disintegration. This effect is probably due to the reinforcing value of the colored pigments used. The mixtures tinted yellow were in better condition than the corroded white leads that had been tinted yellow.

Ocher.—Ocher was tried as a priming coat in several instances, but was found unsatisfactory, as it affected the subsequent coats of paint and caused them to fail rapidly through checking, discoloration, and general bad condition.

CONCLUSIONS.

The inspectors state that from a digest of the various field tests made at Atlantic City, Pittsburg, and Fargo, certain of the type formulas of mixtures, such as are given in the following table, have proved satisfactory in all three climates and seem to demonstrate that such paints would prove of value in any part of the country.

Formulas of pigments that have proved generally satisfactory to scientific section, Paint Manufacturers' Association.

	Percentages.							
	A.	B.	C.	D.	E.	F.	G.	H.
Pigment:								
Basic carbonate white lead	25	40	20	20	38	44	60	......
Zinc oxide	45	40	40	50	48	46	34	27
Basic sulphate white lead	20	......	......	20	......	......	......	60
Zinc-lead	......	......	30	......	......	......	......	......
Barytes	......	13	......	......	......	......	......	......
Blanc fixe	......	4	......	......	......	......	......	......
Silica	......	......	......	......	14	......	......	......
Calcium carbonate	10	......	10	10	......	5	......	3
Asbestine	......	3	......	......	......	5	......	10
China clay	......	......	......	......	......	......	6	......
Vehicle:								
Linseed oil	......	......	......	......	91	86	91	90
Turpentine drier	......	......	......	......	9	12.5	7	......
White drier	......	......	......	......	......	......	......	10
Water	......	......	......	......	......	1.5	2	......

PAINTS FOR PROTECTION OF IRON AND STEEL.

The investigations of paints for this important purpose during the year 1909 have involved studies not only of paint pigments but of paint vehicles. As stated in Mineral Resources for 1908,[a] corrosion in

[a] Mineral Resources U. S. for 1908, U. S. Geol. Survey, 1909, pp. 693–5.

structural steel depends largely on autoelectrolysis, that is, electricity due to currents set up between areas having different potentials in the material itself. These currents require the presence of an electrolyte to serve as a conductor in order to complete the electric circuit; therefore, if a paint film when wet becomes a good conductor of electricity, it may serve as an active aid to corrosion. Experiments have been made by Mr. Henry A. Gardner [a] using oil as a vehicle, in which were ground various pigments ranging from inhibitors to active stimulators of corrosion. It was found that when the paint films were dry no current was conducted by them, but that when wet, if the pigment present were a good conductor of electricity, a perceptible current flowed through the film. On the other hand, when the pigments used were nonconductors, no current passed. The quantity of current depends largely on the degree of activity toward rust stimulation which the pigment possesses. Besides determining whether pigments may be stimulators or inhibitors, a careful study has been made by the scientific section as to the value of various pigments as moisture excluders or moisture shedders. The excluding paint is defined as one that has the property of excluding moisture from steel, and a water-shedding paint is one that has the property of shedding water. Both of these properties may be possessed by certain paint coatings, although the possession of one quality does not necessarily imply the possession of the other. Moisture-excluding paints owe their peculiar properties largely to the composition of the vehicle. Vehicles whose interstices are filled with fused gum are superior in their water-excluding properties. Experiments have shown that plates painted with natural excluding materials which did not shed water were perfectly protected, and that some paints containing pigments that were greasy and unctuous in character and which made good water shedders did not succeed in keeping out the water for more than a short time, because they deteriorated so rapidly. It is believed that moisture goes through a paint coating in two ways, either by forming a compound with the linoxyn coating itself, or by diffusing through the linoxyn, which is more or less a porous membrane. Therefore the use of different pigments should produce more or less permeable films, according to the proportion of space filled up in the vehicle. Experimental work by the scientific section along this line seems to prove that certain pigments have greater power than others of preventing the admission of water through a paint coating. The relative values of thirty-two films made by grinding various pigments either alone or as mixtures in two-thirds raw and one-third boiled linseed oil were determined.[b] Iron oxides with 2 per cent zinc chromate and 2 per cent chromium resinate [c] head the list, with Dutch white lead, white lead plus zinc oxide, and many high-grade pigments following closely as good moisture excluders. It is interesting to note that iron oxide without the chromium resinate in the vehicle falls near the middle of the list, showing that the character of the vehicle is of great importance.

Important results have been obtained from the tests in progress on the steel test fence at Atlantic City.[d] In general the pigments classed

[a] Bull. Sci. Sec. Paint Mfrs. Assoc. No. 18, 1909, pp. 10-11.
[b] Op. cit., p. 21.
[c] Chromium resinate used alone, as a paint, would likely be faulty, but when used in quantities up to 5 per cent in the vehicle, it tends to render the vehicle a more perfect excluder of moisture.
[d] Op. cit., pp. 12-16.

as inhibitors,[a] such as zinc oxide, zinc chromate, zinc and barium chromates, and chromium resinate are standing fairly well, and also many so-called indeterminates, such as white lead, red lead, Venetian red, and iron oxides. The carbonaceous paints, such as graphite, lampblack, and carbon black, all of which have been regarded as stimulators of corrosion, showed intact films, except wherever the plates which were painted with these pigments had been abraded in the least. In such abrasions very active corrosion had started and appeared to be spreading underneath the paint coating. In order to give all the paints a practical test for corrosion on the same basis, each plate of the steel test fence was scratched with the same instrument in its lower right-hand corner, and the progress of corrosion was also observed particularly with reference to the value of the pigment in checking any accelerative action which may be exerted by the linseed oil. Some plates which were primed with red lead and second coated with bitumen and coal-tar paints showed marked "alligatoring" of the bitumen due to unequal expansions of the two coats.

Among the natural mineral paints calcium carbonate and barium sulphate disintegrated very rapidly, scaling from the panels. Calcium sulphate or gypsum showed a marked corrosion, a brown coating of iron rust having developed on those panels and begun to work itself completely under the coating.

The latest inspection of the steel test fence was made by Mr. Gardner on April 15, 1910. Two factors were considered, namely, the condition of the painted surface and the corrosion of the steel surface beneath the paint film. Many important and interesting facts were noted with regard to the standard opaque white pigments, the standard crystalline pigments, the colored pigments, and the carbonaceous pigments. Some of the important points with regard to the opaque pigments are as follows: The condition of surfaces painted with basic carbonate white lead was fair, with much chalking, but the corrosion was very slight. The sublimed white lead showed excellent condition, although there was some chalking, but practically no corrosion. Zinc oxide showed medium condition of surface and considerable corrosion; the imperfections of this film were due to insufficient oil to counteract brittleness. The zinc-lead white showed good condition of surface and little corrosion. Lithopone showed medium condition of surface, and considerable corrosion; the pigments had destroyed the vehicle and permitted chalking and the character of the surface had permitted the access of moisture to the steel surface, so that rusting had proceeded to a considerable extent.

Of the colored pigments sublimed blue lead showed good surface and practically no corrosion. Orange mineral was also in good shape in both respects, but the color had bleached white, and the same may be said of red lead. Bright red oxide of iron showed good condition and a little corrosion. Venetian red showed good surface, but considerable corrosion starting beneath the film, with wart-like eruptions.

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[a] Cushman, A. S. Preservation of iron and steel: Bull. U. S. Dept. Agr. Office Public Roads No. 35, 1909, pp. 23-24.

Of the natural mineral pigments and precipitated pigments, metallic brown showed fair surface and some corrosion. The graphites showed good surface and a little corrosion. Willow charcoal showed good condition in all respects. Mixtures of lampblack and carbon black with barytes both showed fair surface, with active corrosion in areas of abrasions on the plates. Ocher showed medium condition of surface, rather mottled, with eruptions of rust beneath the surface. Both crystalline barytes and blanc fixe showed poor appearance of surface, with pinholing and corrosion. Whiting failed entirely; the paint was entirely gone, due to early chalking, followed by disintegration and the steel plate showed a superficial coating of rust, but not deep pitting. Precipitated calcium carbonate behaved in like manner. Calcium sulphate or gypsum showed poor surface, and much rust had evidently formed early beneath the paint film and spread rapidly. China clay showed good, hard surface, with no chalking and with excellent protection, and asbestine behaved similarly. The chromate paints, such as basic chromate of lead (American vermilion), zinc chromate, zinc and lead chromate, zinc and barium chromate, and chrome green, all showed excellent surface and pronounced inhibitive characteristics. Lead chromate showed some checking and slight cracking, with corrosion beneath. Prussian blue showed smooth, glossy surface, but ultramarine blue was badly chalked and checked, with corrosion proceeding rapidly. Magnetic oxide of iron showed general good condition, except in abraded areas where deep corrosion had occurred.

Coal-tar pigments afforded poor protection on account of deep alligatoring.

Some experiments have been made within the last year by Prof. F. E. Giesecke[a] of the Texas Agricultural and Mechanical College, in order to determine the effect of painting structural steel which is to be imbedded in concrete with Portland cement paint. This coating was made by mixing 1 pound of Portland cement with two-thirds of 1 pound of water, and such a quantity was found sufficient to cover 70 square feet with one coating. The principal fact of importance brought out was that the adhesion between the steel and the concrete was materially increased.

Tests of protective coatings applied to various types of roofing and sheathing materials are still underway at the structural materials laboratories of the United States Geological Survey on Young's Old Pier, at Atlantic City, N. J., but no returns are yet ready for publication. The manner and position in which these plates were exposed are illustrated in a recent publication by Cushman and Gardner, which is a presentation of the latest developments in studies of corrosion and preservation of iron and steel.[b]

PAINTS FOR CONCRETE.

The use of cement concrete for structural purposes has already become world-wide, and it is increasing at a rapid rate. Heretofore little attention has been paid to coatings for concrete. Enough time has now elapsed to show that cement concrete alone is not as durable

[a] Giesecke, F. E., Portland cement paint as a protection to structural steel: Cement Age, December, 1909, pp. 424-429.

[b] Cushman, Allerton S., and Gardner, Henry A., The corrosion and preservation of iron and steel, McGraw-Hill Book Company, New York, 1910.

as might be wished, partly because it is not wholly waterproof, and partly because the cement either contains free lime or develops free lime within itself after setting. Furthermore, concrete in order to compete with other structural materials has had to be economically handled and roughly finished, and its resulting unsightly appearance has detracted from its desirability. It is therefore clear that there is great necessity for both protective and decorative coatings for concrete. The problem of waterproofing concrete is being studied from several standpoints besides that of applying protective coatings. For instance, endeavor to reduce the voids in concrete to a minimum as well as to obtain uniformly finely ground cement and to eliminate the tendency of the cement to form free lime in setting, are all absolutely necessary steps in the production of a waterproof concrete and are the special problems for the manufacturer of cement and the engineer of construction to work out. Much experimental work is underway with regard to waterproofing concrete by means of the addition of various foreign substances in small quantities to the aggregate. Some of these materials are of mineral composition and others are organic. Many compounds are now on the market, but the composition of most of them is not published. Some analyses have been made by the scientific section [a] on a series of compounds widely advertised for use in waterproofing, strengthening, or decorating concrete. Among the materials contained were stearic acid compounds, gums, waxes, soaps, mineral chlorides, inert pigments, and asphalt derivatives. Much interesting information is given regarding the composition of such compounds, although the names of the particular compounds are not given. The possibility of ultimate deleterious effects on concrete from the use of these internal waterproofing materials is a subject for joint study by engineers and paint chemists. In addition to proving the advantages of such materials as water excluders, it should be determined whether they may corrode the steel used in reinforcing concrete, and whether they may affect the set and tensile strength of the cement itself.

It is particularly the province of the paint chemist to study the subject of paint coatings for concrete. Oil coatings have been found to be badly affected by the free lime present, which causes saponification and subsequent solution of the saponified coating. The porosity of cement or concrete surfaces causes an absorption or suction effect that renders it necessary to apply to a given area three or four times as much paint as would cover an equivalent area of wood. Two very important lines of investigation are therefore suggested, the neutralization of the free lime in the cement and concrete, and the proper filling and treatment of the pores of the concrete in order to prevent the suction of any paint that may be applied later. One suggestion that promises to be of great importance in both of these lines has been made by Charles Macnichol, a master painter, of Washington, D. C.[b] Macnichol suggests that a solution of zinc sulphate and water mixed in equal parts by weight (8 pounds zinc sulphate to 1 gallon of water) be used as a priming coat. When applied to concrete surfaces a reaction between the zinc sulphate and the free lime takes place, in so far as the material penetrates the concrete. The products of this reaction are calcium sulphate and zinc hydroxide. There is thus precipitated

[a] Bull. Sci. Sec. Paint Mfrs. Assoc., No. 20, 1909, pp. 14–19.
[b] Painters' Magazine, New York, March, 1908, pp. 223–224.

between the pores of the concrete two practically insoluble pigments, both neutral, and these tend to fill the voids and pores and thus to lessen the suction properties of the concrete, besides having neutralized the free lime in the cement. After the application of this priming coat, oil coatings may probably be applied with good results, although whether an excess of zinc sulphate in this treatment may do any harm has not yet been determined. Other treatments have been suggested, but most of them have been found defective or else too expensive.[a]

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ASBESTOS.

By J. S. Diller.

INTRODUCTION.

The United States has for years led all other countries in the manufacture of asbestos goods, but the raw asbestos for our factories has been almost wholly imported from Canada. A change appears to be taking place in this condition, in view of the decided increase during the year 1909 in the production in the United States of a grade of asbestos which is fairly comparable with that from the Canadian mines. Prior to 1908 practically all the asbestos mined in the United States was of amphibole type, but in 1908 and 1909 the output not only increased more than fourfold over that of 1907, but the increase was almost wholly in chrysotile asbestos. The total production of the United States in 1909 was more than 4.6 per cent of the output of Canada for the same year.

Apart from the increased production in the United States, the principal feature of the asbestos industry in 1909 was the combination of interests. A number of chief producers, whose mines though located in Canada are largely owned in the United States, united in the formation of the Amalgamated Asbestos Corporation (Limited), and will have, it is claimed, a controlling interest in the production and sale of asbestos. Furthermore, some of the larger mine owners and manufacturers, the latter almost wholly in the United States, have combined in organizing the International Asbestos Association, apparently for the purpose of promoting the use of asbestos.

The total production of asbestos in the United States for 1909 was 3,085 tons, an increase of more than 200 per cent over the output of 1908, but this quantity was only about 7 per cent of the raw material asbestos imported free of duty from Canada during the calendar year 1909 to be manufactured in the United States.

Practically only two States, Vermont and Georgia, furnished asbestos to commerce during 1909, both with increased production. Georgia furnished amphibole; Vermont, chrysotile. Very small outputs were reported of amphibole from Idaho and of crysotile from Wyoming, which places them among the producing States.

VARIETIES AND CHARACTERISTICS.

On account of its value the chrysotile asbestos has been much sought for in the United States, and the search should continue in regions where there is a prospect of its occurrence—that is, in regions of ancient crystalline metamorphic rocks. It is useless to search in rocks of any other kind.

The asbestos of commerce includes several fibrous minerals, all of which are characterized by the common and essential property of fibrous structure, and may be classed as either amphibole or serpentine. In amphibole asbestos the fiber is usually brittle and therefore of little value as compared with the serpentine asbestos commonly called chrysotile, which, although finely fibrous and pliable, has sufficient tensile strength to permit of being spun into threads for textile purposes. Only a small part of the chrysotile asbestos produced in this country will spin, and none so far produced is equal in quality to the two best grades produced in Canada, but with exploitation it is hoped that better domestic grades may yet be found in quantity sufficient to be worked commercially.

The best commercial chrysotile occurs in small veins traversing masses of serpentine or closely allied rocks, and the fibers usually run directly across the vein, a feature from which it has been called "cross fiber."

In addition to cross fiber there are two other kinds of asbestos fiber based on the mode of occurrence—slip fiber and mass fiber. Slip fiber occurs in veins; the fiber lies parallel to the vein walls and marks a plane of slipping within the rock, the direction of the fiber showing the direction of the slipping. Mass fiber, unlike cross fiber and slip fiber, does not occur in veins, but forms the whole mass of the rock in which it occurs.

The most valuable and most successfully mined asbestos fiber is in serpentine rock traversed by numerous small veins of cross fiber as well as by more or less slip fiber scattered throughout the rock. All bodies of serpentine should be prospected for asbestos. Asbestos veins in the form of slip fiber only and found in rocks composed chiefly of granular amphibole have not been mined with success in either Georgia or Virginia, but bodies of mass fiber amphibole have been mined more or less successfully for a number of years both in Georgia and Idaho.

USES.

It is the fibrous structure and the flexibility of asbestos, its practical insolubility in ordinary acids, its incombustibility, and its poor conduction of heat and electricity, especially in fiberized, porous masses, that render it most valuable, not only for fireproofing but for insulating against heat and electricity.

One of the first commercial uses of asbestos in the United States was as a binder in various forms of cement used in covering hot blast pipes of the old style of furnace, and later as a covering for steam pipes radiating more heat than can be withstood by the ordinary hair covering. Then came its use in the form of paper sheathing to protect combustible coverings, and later its combination as a binder with magnesia in the manufacture of molded sectional forms.

The covering composed entirely of asbestos fiber is especially good for underground work and for railroad service, as it is not injured by either heat or dampness and withstands the vibration.

Its principal use is in the manufacture of paper goods for building purposes and for pipe coverings, and next to this, in the quantity required, comes the manufacture of asbestos shingles, which are so extensively used in some European countries. Their manufacture began in this country about six years ago. Being both lighter and more uniform in color and shape and also fireproof, shingles made of asbestos are replacing slate. As fireproofing for certain classes of structures comes also asbestos-protected metal, whose use is rapidly growing in favor on account of the consequent lower rates of insurance.

The increased demand for asbestos in fabrics for automobile tires, and more especially as friction facing for automobile brakes, has been most remarkable; and for both high and low pressure steam packing asbestos is said to be replacing rubber.

The enormous increase in the application of electricity as the power of commerce is proportionately increasing the use of asbestos in manufacturing insulating tapes, boards, and similar goods for many special electrical purposes.

The prejudice against the use of asbestos in paint is decreasing, since it has been found that when used in moderation it strengthens the paint and lengthens its life.

The amphibole type of asbestos is used chiefly in the manufacture of retort and furnace cement.

PRODUCTION AND IMPORTS.

The data concerning the production of asbestos in the United States in 1909 were obtained chiefly by the Bureau of the Census in cooperation with the United States Geological Survey.

Nearly all the domestic asbestos produced in 1909 was mined in Vermont and Georgia, there being a small quantity from Idaho and Wyoming. The total output was 3,085 tons, which was within 25 tons of being the largest production ever reported for the United States. The increase over 1908, as already noted, was more than 200 per cent. The actual as well as the proportionate increase in the production of chrysotile asbestos was much greater than that of the amphibole type. The total value of the output was $62,603, as compared with $19,624 in 1908, an increase in 1909 of over 200 per cent. The general average in value per ton was slightly higher than in 1908 as a result of the increased output of the chrysotile type. The outlook for the production of asbestos in the United States is decidedly encouraging, especially in Vermont and Wyoming.

In the following table are given the quantity and the value of the asbestos produced in the United States annually since 1890. With these are given the value of the asbestos imported for consumption, both unmanufactured and manufactured.

Annual production and annual value of imports of asbestos into the United States, 1890–1909.

Year.	Production.		Value of imports.		
	Quantity (short tons).	Values.	Unmanufactured.	Manufactured.	Total.
1890	71	$4,560	$252,557	$5,342	$257,899
1891	66	3,960	353,589	4,872	358,461
1892	104	6,416	262,433	7,209	269,642
1893	50	2,500	175,602	9,403	185,005
1894	325	4,463	240,029	15,989	256,018
1895	795	13,525	225,147	19,731	244,878
1896	504	6,100	229,084	5,773	234,857
1897	580	6,450	263,640	4,634	268,264
1898	605	10,300	287,636	12,897	300,533
1899	681	11,740	303,119	8,949	312,068
1900	1,054	16,310	331,796	24,155	355,951
1901	747	13,498	667,087	24,741	691,828
1902	1,005	16,200	729,421	33,011	762,432
1903	887	16,760	657,269	32,058	689,327
1904	1,480	25,740	700,572	51,290	751,862
1905	3,109	42,975	776,362	70,117	846,479
1906	1,695	28,565	1,010,454	65,716	1,076,170
1907	653	11,899	1,104,109	200,371	1,316,379
1908	936	19,624	1,068,322	127,548	1,195,870
1909	3,085	62,603	993,278	240,381	1,233,659

Canada continues to be so greatly the most important source of the raw asbestos used in the United States as to render the other possible sources of small consequence.

Raw asbestos is imported duty free; on manufactured asbestos there are duties of 25 and 40 per cent. Canada exported asbestos during the calendar year ending December 31, 1909, to the value of $1,729,857. The total value of the raw asbestos imported into the United States for the same year was $993,278, and it is doubtful if 5 per cent of it was derived from any other source than Canada. The following statement, by countries, of the value of the unmanufactured asbestos imported into the United States for the fiscal years ending June 30, 1908 and 1909, throws light on the matter:

Value of imports of unmanufactured asbestos into the United States for the fiscal years ending June 30, 1908 and 1909, by countries.

Country.	1908.	1909.
Germany	$1,036	$11,031
Italy	982	56
Russia in Europe		9,774
United Kingdom	48,038	20,623
Total for Europe	50,056	41,484
Canada	1,065,744	979,906
Grand total	1,115,800	1,021,390

The total value of the manufactured asbestos imported during the same period was $376,107, of which only $228 was from Canada.

PRICES AND CONDITIONS OF TRADE.

Trade conditions were reported normal during 1909, except in the Middle and New England States, where the asbestos industry was said to be somewhat sluggish in the use of shorter fibers for making paper and for similar purposes. This was due, not to any decrease in the use of asbestos but apparently to the increased domestic production of the grades employed.

The prices of both amphibole and chrysotile domestic asbestos, which can not be made public, come well within the range of prices quoted below for the Canadian product in 1908 and 1909, although no lowering of price in 1909, corresponding to that for the Canadian product, was reported from the domestic mines.

Prices f. o. b. at Canadian mines in the calendar years 1908 and 1909, as reported by the Canadian bureau of mines, were as follows:

Prices, by grades, of Canadian asbestos in 1908 and 1909, per short ton.[a]

Grade.	1908.	1909.
Crude asbestos No. 1	$300.59	$270.37
Crude asbestos No. 2	165.38	152.11
Mill stock asbestos No. 1	80.54	53.18
Mill stock asbestos No. 2	29.33	24.70
Mill stock asbestos No. 3	9.29	9.37
Asbestic	0.74	0.72

[a] Preliminary Rept. on the mineral production of Canada during the calendar year 1909: Mines branch, department of mines, Ottawa, 1910, p. 14.

FOREIGN PRODUCTION AND CONDITIONS.

CANADA.

The production of asbestos in Canada is a matter of great importance to the United States, since it is the source from which the States draw nearly all the raw asbestos for a large manufacturing industry whose development is based on the free entry of the Canadian product. Furthermore, many of the Canadian mines are owned by manufacturers resident in the United States, which fact gives their operations an added interest.

Production of asbestos and asbestic in Canada for the calendar years 1895–1909, in short tons.[a]

Year.	Asbestos.		Asbestic.	
	Quantity.	Value.	Quantity.	Value.
1895	8,756	$368,175	....	....
1896	10,892	423,066	1,358	$6,790
1897	13,202	399,528	17,240	45,840
1898	16,124	475,131	7,661	16,066
1899	17,700	468,635	7,746	17,214
1900	21,621	729,886	7,520	18,545
1901	32,892	1,248,645	7,325	11,114
1902	30,219	1,126,688	10,197	21,631
1903	31,129	915,888	10,548	16,869
1904	35,611	1,213,502	12,854	12,850
1905	50,669	1,486,359	17,594	16,900
1906	60,761	2,036,428	21,424	23,715
1907	62,130	2,484,768	28,296	20,275
1908	66,548	2,555,361	24,225	17,974
1909	63,349	2,284,587	23,951	17,188

[a] Obtained from the report of the director of mines on the mines and metallurgical industries of Canada for 1907–8, pp. 448, 936. The data for 1908 and 1909 were obtained from the preliminary report in 1910 (subject to revision) on the mineral production of Canada during the calendar year 1909, pp 4, 6.

The most important matter in connection with the asbestos industry of Canada during 1909 was, as already mentioned, the consolidation of interests resulting in the formation of the Amalgamated Asbestos Corporation (Limited). The Canada department of mines in its preliminary statement reports that the actual shipments of asbestos were 4.8 per cent less in 1909 than in 1908, but that the stocks on hand at the end of the year were considerably larger than on December 31, 1908. The comparison of the shipments of the four best grades shows that the shipments of crude No. 1 and mill stock No. 1 were actually greater in 1909 than in 1908, but that the shipments of crude No. 2 and mill stock No. 2 during the same time were less. As to the value per ton, however, there was a considerable decline in each one of the four grades.

According to Fritz Cirkel,[a] there are 10 companies working in the asbestos district of Canada, with 19 quarries and mills, employing in the summer season over 3,000 persons. The combined capacity of all the mills is 8,250 tons of rock per day. The greatest Canadian quarry, the King's pit, has been in operation for more than twenty-five years, and has contributed about one-third of the whole Canadian production.

[a] Cirkel, Fritz, Eng. and Min. Jour., April 30, 1910, p. 919.

RUSSIA.

As noted in this report for 1908, Russia is becoming an important producer of asbestos, but, owing to difficulties in mining and transportation in the Urals, where the mines occur, only the better grades reach the general markets. The growth of the industry is indicated by the fact that in 1893 the total output was 1,167 tons, which in 1907 had increased to 10,308 tons; and, according to special correspondence of the Mining World[a] (Chicago), the latest available information, the output for the Urals increased from 600,143 poods (10,802 short tons) in 1908 to 814,134 poods (14,654 short tons) in 1909, which is more than 23 per cent of the total production of the Canadian mines for the same year.

SOUTH AFRICA.

A marked increase in the production of asbestos has been predicted for South Africa by J. J. Harpell.[b] The government returns of exports from British South Africa show that the output increased from 305 tons in 1903 to 580 tons in 1906, to 1,605 tons in 1908, and at a still greater rate for the first six months of 1909. The average price during 1908 was $67.40 per ton. The most important deposits of asbestos yet worked in South Africa are in Cape Colony. Transvaal, South Rhodesia, and Natal, according to Harpell, contributed to this production for the first time in 1908.

AUSTRALIA.

In the Mining Journal[c] (London), Mr. C. W. Marsh, of Dardanup, gives an account of the North Bar chrysolite asbestos formation of Western Australia, about 90 miles from the coast. It is said that the deposits are large and that 10 to 20 per cent of the mass is fiber, an unusually large proportion, which is reported workable on a large scale, but it is stated that the market value of the fiber has not yet been proved.

OTHER COUNTRIES.

A small quantity of asbestos is mined in Japan, France, Italy, Corsica, Greece, Turkey, and Ceylon.

NOTES ON ASBESTOS DEPOSITS OF THE UNITED STATES.

GENERAL STATEMENT.

The fact that the great belt of ancient crystalline rocks, which contain the extensive deposits of asbestos so profitably mined in Canada, stretches southwestward from the Province of Quebec with many variations through New England, the Middle, and the South Atlantic States into Alabama, naturally leads to the expectation of finding similar deposits in the United States. They have been sought for all along the line, but as yet, with the exception of one locality in Georgia and another in Vermont, the successful mining of asbestos is confined

[a] Mining World (Chicago), September 24, 1910, p. 558; see also Canadian Mining Jour., September 1, 1910, p. 520.
[b] Canadian Min. Jour., January 15, 1910, p. 50.
[c] Marsh, C. W., Mining Jour. (London), September 25, 1909, p. 394.

to Canada. Asbestos has been found and prospected at many localities from Massachusetts to Georgia, inclusive, but in quality it is generally of the amphibole type and in quantity so irregularly distributed so far as known as to afford but little promise of a successful basis for the development of an industry. The search should continue. The better grade of material, chrysotile, is associated with serpentine derived from peridotite, a rock of which olivine was originally the chief constituent.

West of the great Appalachian belt in the United States similar rocks containing more or less asbestos reappear in portions of the Rocky Mountains in Wyoming and Idaho and in the ranges along the Pacific coast.

VERMONT.

The Lowell Lumber and Asbestos Company, on the property formerly known as the Tucker property, has made decided progress in the development of its mine and the output of its mill, and gives to Vermont the first rank among the States in the production of asbestos.

The mine is being developed at the same level on both sides of a prominent serpentine ledge and can readily be made tributary to the mill by the same tramway. The fresh exposures brought to light at greater depth in the mass of serpentine by the progress of the mining show a large mass of fair milling rock, more or less abundantly veined with a good grade of cross-fiber chrysotile and locally crushed and filled with slip fiber of the same character. The mine is located on the edge of a large mass of serpentine, which forms prominent bluffs along the lower slope of Belvidere Mountain and renders economical mining possible.

The mill, which was described briefly in the report for 1908,[a] has been somewhat extended and improved by the introduction of a double cylinder rotary drier of great efficiency, and by the extension and subdivision of the air separation.

A new road is completed to the mill, and the plant is well equipped, having a traction engine and several trucks to haul the 20-ton loads of asbestos 12 miles to Hyde Park on the railroad and return with fuel oil for the engine which furnishes power for the mine and the mill.

As the development of the mine advances and its production increases, it is of special interest to note the testimony of manufacturers who use the fiber. The president of one of the largest manufacturing companies writes, "We have used many carloads of the two or three grades produced by Mr. Gallager. Of course, this property has not yet produced any grades such as No. 1 or 2 crude, but what they do produce in the way of paper stock and long fiber is perfectly satisfactory and compares very favorably with similar grades from Canada."

Dr. C. H. Richardson has recently made a special report on the asbestos deposits of Vermont for Prof. G. H. Perkins, state geologist, which will appear in the forthcoming volume of the Vermont state geologist's report on the mineral industries of Vermont for 1909–10.

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[a] Asbestos: Mineral Resources U. S. for 1908, U. S. Geol. Survey, 1909, p. 704.

GEORGIA.

In Georgia only one grade of amphibole asbestos is mined by the Sall Mountain Asbestos Company, but it is mass fiber, that is, it forms the whole mass of the rock and in this respect is strikingly unlike slip fiber and cross fiber, both of which are vein deposits. The Sall Mountain asbestos mine is the only one at work in the State, and is the oldest asbestos mine now operating in the United States. The occurrence of these irregular lenticular fibrous masses of highly altered igneous rock is briefly described in the report on absestos for 1907.[a] The output of the mine in 1909 increased about 25 per cent over that of 1908. Other localities of promise in the region are being prospected. Ten carloads of asbestos from Sall Mountain were used in lining the flues of the Ducktown, Tenn., smelter.

ARIZONA.

Great interest still continues in the Grand Canyon deposit of silky chrysotile; but notwithstanding the high grade and great length of the fiber, the limited thickness of the deposit and the serious difficulties of transportation resulting from its situation in the depths of the Grand Canyon of the Colorado make its development problematical.

WYOMING.

Coincident with the consolidation of the asbestos interests of the larger producers in Canada, much speculation in asbestos properties has been carried on in parts of this country, and nowhere more vigorously, apparently, than in Wyoming.

There has been much prospecting for some years in the Smith Creek and Casper Mountain region of Wyoming. The four companies which control nearly all these claims are the North American Asbestos Company, the Wyoming Consolidated Asbestos Company, the United States Asbestos Company, and the International Asbestos Mill and Power Company. The International Asbestos Mill and Power Company has leased the holdings of the North American and the Wyoming Consolidated companies and is erecting two mills, one on Casper Mountain and the other on Smith Creek. The mill on Smith Creek was practically completed in July, 1910, and has since begun operations under the superintendence of H. L. Parker, whose experience in the Canadian asbestos mines and mills gives promise of a well-directed endeavor to mine the Wyoming asbestos successfully. The mill is small but well arranged and conveniently located for economical handling of the material. One of its most important parts is the Parker asbestos Jumbo-fiberizer which was invented by C. H. Parker, of Thetford, Canada, and is said to have successfully replaced the Cyclone pulverizer in some of the leading Canadian mills.

Nearly 1,700 pounds of chrysotile asbestos rock was shipped from Casper, Wyo., to Vermont and fiberized by Mr. E. B. Craven, at the mill of the Lowell Lumber and Asbestos Company. Mr. Craven reports that the sample weighed 1,690 pounds before crushing, and from it was extracted the following commercial product:

[a] Mineral Resources U. S. for 1907, U. S. Geol. Survey, 1908, pp. 716–718.

Commercial product from 1,690-pound sample of asbestos from Casper, Wyo.

	Pounds.
No. 1[a] fiber	138
No. 2 fiber	83
No. 3 fiber	80
No. 4 fiber	90
No. 5 fiber	353
No. 6 fiber (for paint)	4

a total of 748 pounds of fiber extracted, or 44 per cent of the sample. It is evident that the sample was carefully selected and that this rock is of much higher grade, both in quality and quantity, than the average rock as mined.

IDAHO.

A remarkable occurrence of mass fiber of the amphibole type has recently been developed at a number of points about 14 miles southeast of Kamiah, Idaho. The rock is very like that mined at Sall Mountain, Ga., except that in Idaho the fibers are somewhat coarser and the radial groups larger. It forms lenticular masses of various sizes. Some of them make prominent ledges 200 feet in length and 35 feet in height, and it is evident when all the outcrops are considered that the asbestos rock is abundant and may well serve as the basis of an industry.

The asbestos rock in blocks of various sizes up to 1 ton in weight is hauled 14 miles to Kamiah and shipped by rail to Spokane, where the Spokane Asbestos Fire Brick Company proposes to saw up the larger fragments into fire brick and to pulverize the greater portion of the rock, roughly assorting the powder by means of a strong blast of air from a fan and thus preparing to manufacture fireproof plaster, asbestos cement, and sectional pipe covering for pipes and boilers.

The Canadian fiber in general is of better quality than that of Kamiah, but its high cost affords a fair basis for the development of a local industry at Spokane in the manufacture of structural material from the Kamiah asbestos.

OTHER STATES.

Suggestive specimens of cross-fiber veins of asbestos in serpentine similar to that of Casper, Wyo., and of mass fiber like that of Kamiah, Idaho, have been sent to the Geological Survey from Helena, Mont., but nothing further has been learned concerning the localities from which they came.

Active prospecting continues in Placer County, Cal., near Dutch Flat, but no asbestos has been marketed from that locality.

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[a] These grades do not correspond to the grades on p. 6.

ASPHALT.

By David T. Day.

PRODUCTION.

Of the various kinds of asphalt which have been fully described in previous reports of this series, the total production in 1909 amounted to 228,655 short tons, valued at $2,138,273, an increase from 198,382 tons, valued at $2,057,881, in 1908. The production was not so great as the maximum yield in 1907, as is shown in the table below:

Production of asphalt and bituminous rock, 1882–1909, in short tons.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
1882	3,000	$10,500	1896	80,503	$577,563
1883	3,000	10,500	1897	75,945	664,632
1884	3,000	10,500	1898	76,337	675,649
1885	3,000	10,500	1899	75,085	553,904
1886	3,500	14,000	1900	54,389	415,958
1887	4,000	16,000	1901	63,134	555,335
1888	50,450	187,500	1902	105,458	765,048
1889	51,735	171,537	1903	101,255	1,005,446
1890	40,841	190,416	1904	108,572	879,836
1891	45,054	242,264	1905	115,267	758,153
1892	87,680	445,375	1906	138,059	1,290,340
1893	47,779	372,232	1907	223,861	2,826,489
1894	60,570	353,400	1908	198,382	2,057,881
1895	68,163	348,281	1909	228,655	2,138,273

Bituminous rock showed an increase from 37,371 tons in 1908 to 55,376 tons in 1909, and most of the other important varieties also shared in the increase in production. The greatest element in the supply is oil asphalt, which amounted to more than half of the total product in both years; it should show further increase in 1910, owing to the great increase in the production of asphaltic oils in California and Texas, the main sources of supply for this form of residuum.

The following table shows the production of asphalt by varieties from 1906 to 1909, inclusive:

Production of asphalt, 1906–1909, by varieties, in short tons.

Variety.	1906		1907		1908		1909	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Bituminous rock	24,085	$70,686	45,526	$129,040	37,371	$146,821	55,376	$205,756
Refined bitumen	2,543	24,158	1,744	16,568	4,536	48,780	733	6,964
Gum	24,178	341,106	5,195	78,400	7,000	88,000	10,220	105,220
Maltha	9,900	86,750	13,507	143,758	12,875	162,000	652	8,047
Wurtzilite (elaterite) } Gilsonite	12,947	159,960	422	35,327	450	36,000	220	1,400
Gilsonite			20,285	531,965	18,533	61,824	28,669	218,186
Grahamite	1,952	16,432	966	7,743	2,286	20,340	3,894	32,737
Ozokerite and tabbyite			12	2,148	50	2,500	30	1,500
Oil asphalt	62,454	591,248	136,204	1,881,540	115,281	1,491,616	128,861	1,558,463
Total	138,059	1,290,340	223,861	2,826,489	198,382	2,057,881	228,655	2,138,273

The following table shows the production of asphalt, by States and kinds in 1908 and 1909:

Production of asphalt in 1908 and 1909, by varieties and by States, in short tons.

1908.

Variety.	California.		Utah.		Oklahoma.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Bituminous rock	27,118	$91,998				
Mastic	3,250	36,563				
Refined bitumen	7,000	88,000				
Maltha	12,759	158,520			116	$3,480
Uintaite (gilsonite)			18,533	$61,824		
Wurtzilite (elaterite) and tabbyite			500	38,500		
Grahamite					2,286	20,340
Oil asphalt	85,114	972,176				
Total	135,241	1,347,257	19,033	100,324	2,402	23,820

Variety.	Kentucky.		Texas.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Bituminous rock	10,253	$54,823			37,371	$146,821
Mastic	1,286	12,217			4,536	48,780
Refined bitumen					7,000	88,000
Maltha					12,875	162,000
Uintaite (gilsonite)					18,533	61,824
Wurtzilite (elaterite) and tabbyite					500	38,500
Grahamite					2,286	20,340
Oil asphalt			30,167	$519,440	115,281	1,491,616
Total	11,539	67,040	30,167	519,440	198,382	2,057,881

1909.

Variety.	California.		Utah.		Oklahoma.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Bituminous rock	33,788	$114,869			6,423	$12,846
Mastic						
Refined bitumen	10,220	105,220				
Maltha	550	5,500			102	2,547
Uintaite (gilsonite)			28,669	$218,186		
Wurtzilite (elaterite) and tabbyite			250	2,900		
Grahamite					*a* 3,894	32,737
Oil asphalt	82,557	701,259				
Total	127,115	926,848	28,919	221,086	10,419	48,130

Variety.	Kentucky.		Texas.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Bituminous rock	15,165	$78,041			55,376	$205,756
Mastic	733	6,964			733	6,964
Refined bitumen					10,220	105,220
Maltha					652	8,047
Uintaite (gilsonite)					28,669	218,186
Wurtzilite (elaterite) and tabbyite					250	2,900
Grahamite					3,894	32,737
Oil asphalt			46,304	$857,204	128,861	1,558,463
Total	15,898	85,005	46,304	857,204	228,655	2,138,273

a Includes small output from West Virginia.

A significant increase is noted in the gilsonite and uintaite produced in eastern Utah, for which the railroad facilities from Dragon, Utah, to the main line of the Denver and Rio Grande Western Railroad, at Mack, Colo., were considerably increased during 1909. This led also to further efforts to market elaterite and the associated mineral, tabbyite. There is a persistent effort to develop these minerals for the production of a substitute for rubber by a special process already referred to in these reports. Material very similar to rubber can be produced, for which good wearing qualities are claimed when used in automobile tires and elsewhere. Tests of the material for these uses are now being made. During the year varieties of bitumens similar to elaterite and tabbyite were discovered and given names, such as aeonite, to a material quite similar to ordinary elaterite, and wiedgerite, to a soft, moist material about the color and consistency of liver, which turns black on exposure. This wiedgerite, which is somewhat high in sulphur, is said to be especially valuable for the manufacture of rubber substitutes.

IMPORTS.

The following table shows the imports of asphalt by calendar years from 1905 to 1909, inclusive:

Asphalt imported for consumption into the United States, 1905–1909, in short tons.

Year.	Crude.		Dried or advanced.		Bituminous limestone.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1905	85,014	$381,474	9,688	$78,639	5,895	$19,183	100,597	$479,296
1906	100,818	355,493	14,178	114,076	5,086	15,110	120,082	484,679
1907	142,494	502,811	13,535	127,024	4,925	15,629	160,954	a 648,564
1908	137,808	532,297	7,642	67,364	6,224	20,758	151,674	a 624,979
1909	128,109	511,631	10,087	94,146	6,409	18,440	144,605	a 633,205

a Imports for 1907 include $3,100 of manufactures; 1908, $4,560; 1909, $8,988.

EXPORTS.

During the fiscal year ending June 30, 1909, domestic asphalt and manufactured asphaltic material to the value of $425,429 were exported from the United States, as against similar exports valued at $451,968 in 1908 and $374,476 in 1907.

EXPORTS FROM TRINIDAD.

The exports of asphalt from Trinidad from 1905 to 1909, inclusive, are shown in the following table:

Total exports of asphalt from Trinidad, 1905–1909, in short tons.

Year.	To United States.			To Europe.			To other countries.			Grand total.
	Lake.	Land.	Total.	Lake.	Land.	Total.	Lake.	Land.	Total.	
1905 a	53,701	13,581	67,282	54,640	577	55,217	5,900	286	6,186	128,685
1906 b	71,902	5,292	77,194	68,284	454	68,738	....	....	....	145,932
1907 c	97,243	4,642	101,885	59,987	224	60,211	....	230	230	162,096
1908 d	92,212	5,886	98,098	51,183	1,276	52,459	....	....	....	150,557
1909	97,629	13,787	111,416	49,345	224	49,569	....	....	....	160,985

a Year ending January 31, 1906.
b Year ending January 31, 1907.
c Year ending January 31, 1908.
d Year ending January 31, 1909.

FULLER'S EARTH.

Compiled by F. B. Van Horn.

INTRODUCTION.

The latest report on fuller's earth issued by the United States Geological Survey covered the calendar year 1907. Since that time no new work on the subject has been undertaken by this bureau. The edition of the report for 1907 has been exhausted, and it has been thought best to republish it with the addition of statistics for 1908 and 1909. This report is to be regarded as merely a compilation, and material derived from the books and papers of the authors indicated in the bibliography has been freely used as to both substance and wording.

The term "fuller's earth" is used to include a number of substances that possess strong absorbent properties. The material was originally used for cleansing cloth of grease and also for cleaning furs, but it is now mainly used in this country for clarifying oils.

Dana defines fuller's earth as including many kinds of "unctuous clays, gray to dark green in color, and being in part kaolin and in part the mineral smectite." It is placed by him with other claylike minerals (all of them hydrous silicates), namely, smectite and malthacite, of not very definite composition, but all containing a large percentage of combined water. It is inferred that Dana considers these minerals the cause of the bleaching power of fuller's earth.

Ries defines fuller's earth as a claylike substance that has the property of decolorizing or clarifying oils. He says:

> An ultimate chemical analysis shows it to differ from most ordinary clays in having usually a high percentage of combined water and a low amount of alumina. There is probably a large amount of hydrous silica present. Fuller's earth possesses little or no plasticity, and in order to work properly has to be ground very fine. A chemical analysis is of little value at present in determining its quality; only a practical test suffices.

Geikie defines fuller's earth as "a greenish or brownish, earthy, soft, somewhat unctuous substance, with a shining streak, which does not become plastic with water, but crumbles down into mud. It is a hydrous aluminous silicate with some magnesia, iron oxide, and soda." According to Geikie, fuller's earth owes its detergent properties to physical characteristics rather than to chemical composition.

John T. Porter, in an article on the "Properties and tests of fuller's earth," presents a very interesting theory. He says that it is evident that Dana's theory will not stand, since the discovery of American deposits having a comparatively low percentage of combined water. Such earths could not possibly have as their base either smectite or malthacite, although they might contain very small quantities of these minerals.

Porter says that his analyses have confirmed Ries's statement that fuller's earth contains appreciable amounts of hydrous silica. However, it is evident that if the bleaching power of fuller's earth is due to this hydrous silica, treatment of the earth with boiling carbonate or hydrate of soda, which removes the silica, should destroy this bleaching power. He has tried this experiment on several earths, and although the results are not entirely concordant, yet there can be no doubt that fuller's earth retains at least a part of its efficiency after treatment by alkalies. It is also plain that carbonate of soda has a much less harmful action on the earth than the hydrate. As Fresenius and other authorities state that hydrous and amorphous silica are freely soluble in hot carbonate of soda, as well as in sodium hydrate, this difference can hardly be due to nonsolution of the silica by the carbonate, but is almost entirely due to partial decomposition of the earth by sodium hydrate. In this connection he noticed that sodium hydrate appears to extract considerable alumina as well as silica, but the carbonate does not. Fuller's earth after treatment with sodium hydrate is left in a very gelatinous condition and is extremely hard to filter and wash. For this reason it is possible that some of the samples treated retained considerable amounts of soluble salts after washing, although great pains were taken to remove them, and this may have had some influence on the results.

Another fact which might be used as an argument against this theory is that hydrous silica artificially prepared has but very slight bleaching powers. These results are naturally not conclusive, as the silicic acid occurring naturally may differ either physically or chemically, or both, from the artificial product.

On the other hand, some earths still retain a considerable portion of their bleaching power after decomposition by acids, consisting then of 80 per cent or more of silica; and from this it seems probable that hydrous silica when prepared in certain ways may have some small efficiency.

Porter says, in conclusion, that he thinks he is justified in stating, first, that hydrous silica does not of itself possess bleaching power, although it may at times possess some efficiency as a result of existing in a certain physical condition; and second, that it is certain that fuller's earth can not owe more than a small part of its peculiar properties to the presence of free silicic acid.

Porter offers a new theory to explain the clarifying action of fuller's earth. It is based on the presence of a group of aluminum hydrosilicates existing in the form of pectoids.

The theory which he has devised to explain the peculiar properties of fuller's earth may be stated as follows:

1. Fuller's earth has for its base a series of hydrous aluminum silicates.

2. These silicates differ in chemical composition.

3. They are, however, similar in that they all possess an amorphous colloidal structure.

4. The colloidal structure is of a rather persistent form and is not lost on drying at a temperature of 130° C., or possibly higher.

5. These colloidal silicates possess the power of absorbing and etaining organic coloring matter, thus bleaching oils and fats.

In this statement Porter used the word colloidal in its broadest ense—to cover the whole range of conditions expressed by the ords colloid, pectoid, and hydrogel. It is his opinion that the word ectoid would most properly express the condition of the active onstituents of fuller's earth, but it is not impossible that these may o into partial solution in oil and thus become true colloids.

Colloids possess the power of taking up organic colors from soluion and the analogy with fuller's earth is so apparent as to excite urprise that it has not been studied with this idea in mind before. t has even been known that pectoids could extract colors from oils nd resins as well as aqueous solutions. Porter regards this as a trong point in favor of the colloidal theory, although by itself it oes not, of course, constitute proof.

The power of colloids to absorb certain salts, or at least the basic ons of these salts, has been known a long time. This power is also ossessed to a degree by certain amorphous substances having a ne porous structure, such as charcoal and boneblack. Fuller's arth has this property to a marked degree. In fact, its use has been roposed to remove the lime from boiler water. Porter has found hat after it has absorbed ammonia or salts it loses a great part of its fficiency in bleaching oils. From this he infers that it absorbs the ases in the manner in which it absorbs the coloring matter of oil, he bases occupying pores which otherwise would hold the color.

It has been pointed out that these absorbent materials have a elective action on the salts, absorbing the unlike ions and discarding he ions of like chemical nature. If colors in oil solution are absorbed the same manner as salts in aqueous solution, analogy would lead the supposition that fuller's earth would exert a selective action r certain classes of coloring matter and, moreover, that the earths hemselves would differ in their selection of colors according as they re more or less acidic in composition. This is stated to be in ccordance with the facts.

In the course of his oil tests Porter noticed that on the same sample f oil different materials give products varying greatly in shade, the ain color in some tests being of a yellow and in others of a green int. Is it not likely that the oil contains several compounds of arying chemical nature, and that the earths or other materials used bleaching extract them in ratios proportional to their own basicity r acidity? He has been unable to obtain any exact data on this oint from his results, owing to the difficulty of following these slight hanges in tint with the unaided eye. A tintometer would be eeded if this line of investigation were to be followed out.

MINING AND PREPARATION.

The fuller's earth in Florida is usually mined by pick and shovel nd hauled to the mill, where it is broken up into small lumps and ut through rotary driers. It is then taken by elevator to the ushers and ground and bolted into several grades, 120 mesh being e finest. The material is then ready for shipment.

PRODUCTION.

Fuller's earth was first discovered in the United States at Quincy, Fla., in 1893. The States producing it in 1909, in order of importance, were: Florida, Georgia, Arkansas, Massachusetts, Alabama, Texas, California, and Colorado.

During the year 1909 the marketed production of fuller's earth in the United States was 33,486 short tons, valued at $301,604. This was an increase from the year 1908 of 3,772 tons in quantity and of $23,237 in value. Of the entire production in 1909, Florida furnished 22,470 tons, or 67.1 per cent.

The following table shows the production of fuller's earth in the United States since the beginning of production in 1895:

Production of fuller's earth in the United States, 1895–1909, in short tons.

Years.	Quantity.	Value.	Years.	Quantity.	Value.
1895	6,900	$41,400	1904	29,480	$168,500
1896	9,872	59,360	1905	25,178	214,497
1897	17,113	112,272	1906	32,040	265,400
1898	14,860	106,500	1907	32,851	291,773
1899	12,381	79,644	1908	29,714	278,367
1900	9,698	67,535	1909	33,486	301,604
1901	14,112	96,835			
1902	11,492	98,144	Total	299,870	2,372,108
1903	20,693	190,277			

IMPORTS.

During 1909 the imports of fuller's earth were 11,386 long tons, valued at $101,151. The quantity and value of imports into the United States since 1901 are shown in the following table:

Fuller's earth imported into the United States, 1901–1909, in long tons.

Years.	Unwrought or unmanufactured.		Wrought or manufactured.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1901	2,916	$17,230	7,850	$63,467	10,766	$80,697
1902	3,785	26,635	9,728	75,945	13,513	102,580
1903	3,804	28,339	11,464	92,332	15,268	120,671
1904	1,763	9,546	7,363	64,460	9,126	74,006
1905	1,522	12,798	11,480	93,199	13,002	105,997
1906	2,594	20,129	10,643	88,566	13,237	108,695
1907	2,223	16,833	12,425	105,388	14,648	122,221
1908	2,110	16,242	8,753	77,171	10,863	93,413
1909	1,609	12,492	9,777	88,659	11,386	101,151
Total	22,326	160,244	89,483	749,187	111,809	909,431

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GEMS AND PRECIOUS STONES.

By Douglas B. Sterrett.

INTRODUCTION.

Features of the precious stones industry during 1909 were the large increase in output of turquoise and turquoise matrix, variscite, tourmaline, and chrysoprase, and the discovery of a new and promising emerald prospect in North Carolina, of new variscite and turquoise deposits in Utah and Nevada, and of a vein of delicately colored rhodonite in California. Blue and green matrix stones increased so greatly in popularity that over 17 tons of rough turquoise and 3½ tons of variscite were mined to supply the demand. Variscite has now nearly gained a permanent place for itself in the popular demand and is to a certain extent displacing the poorer grades of turquoise matrix. A large increase in the output of tourmaline was probably caused in part by the increasing demand for the pink variety by the Chinese merchants in the southern California cities. A new emerald prospect has been discovered in North Carolina near a locality where two emeralds are reported to have been found some years ago. Crystals from the new find have yielded very promising gem material.

Several new trade names have been applied to minerals and rocks recently adopted for use as gems. Among these names are "apricotine" for yellowish-red quartz pebbles, "creoline" for a purplish epidotized trap rock, "verdolite" for a talcose dolomitic breccia rock, "wabanite" for a banded cream and purplish chocolate slate, "carmazul" and "chrysocarmen" for certain copper-ore gems, and "chalchihuitl" for the beautiful calamine obtained from Mexico. Some of these stones are sufficiently beautiful to be used in good grades of jewelry. All of them should fill needs in arts and crafts work. A number of other such minerals and stones have been cut to which no special names have been applied; they are described under the heading "Miscellaneous gems."

AGATE.

ARIZONA.

Specimens of chalcedony or agate and jasper from Mohave County were very kindly furnished by Mr. John F. Gross, of Mineral Park, Ariz. Mr. Gross states that they were found over a stretch of country 2 miles long, about 18 miles southwest of Kingman. These minerals were found on "malpais" mesa land and the hillsides above, The chalcedony occurs in mammillary masses up to an inch in thickness. It ranges in color from translucent gray to reddish and brown. The mammillary lumps are banded, and where some of the layers are stained with iron oxide would make very pretty agates. Some of the rounded surfaces are glassy and resemble hyaline opal. The jasper is similar to that found in many places in the Southwestern States. It ranges in color from reddish-gray to various shades of red, purplish, and black, or Lydian stone. Some of the lighter specimens show a mottling in color. None of the material from this locality has been sold, and no regular work has been done on the deposit.

Specimens of opal and chalcedony were also very kindly sent to the Survey by Mr. Ross H. Blakely, of Kingman, Ariz. These specimens came from the western slope of the Aquarius range of mountains in the southeastern part of Mohave County, about 10 or 12 miles from Owens post office on Big Sandy Creek. Mr. Blakely describes the country as very rough with high ridges and deep canyons. The formations are limestone in porphyry or granite. The opal occurs in many layers, like a bedded formation along a hillside. No gem or precious opal had been found, though only the surface had been prospected. The specimens provided consisted of seams and nodules of opal and chalcedony. The opal varies from translucent white to gray, yellowish, and blue or bluish-green. The chalcedony is gray with some grading into carnelian red and into opaque red jasper. A little moss-agate marking is present in some specimens. It is uncertain whether part of the material should be classed as opal or as chalcedony. It is probable that this deposit will be tested by Mr. Blakely.

COLORADO.

Fancy agates suitable for gem and specimen material have been obtained in some quantity by Mr. J. D. Endicott, of Canon City, Colo., from the Curio Hill locality and the Dinosaur beds near Canon City. These agates cut very prettily and are in some demand. Some of the blue chalcedony from Thirty-one Mile Mountain was also obtained for cutting.

WASHINGTON.

Dr. O. C. Farrington, of The Field Columbian Museum, of Chicago, reports that dealers at the Seattle Exposition sold a considerable number of fossil brachiopod and nautilus shells replaced by white and brown chalcedony. It is said that these fossils were obtained from the San Juan Islands, Washington.

INDIA.

The occurrence of carnelian and agate in India has been described by P. N. Bose.[a] The deposits are in the vicinity of Ratanpur, Damlai, and Dholikuva in the Rajpipla State. The carnelians and agates are found as fairly well rounded pebbles and cobbles, called "akik," in the conglomerates of the upper group of the Tertiary system. These pebbles have evidently been derived from the disintegration of former trap beds in which they formed geodes and veins.

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[a] Rec. Geol. Survey India, vol. 37, pt. 2, 1908, pp. 176-190.

The akik pebbles are generally 2 or 3 inches in greatest length. The gem-bearing beds are worked by pits ranging in depth from 20 to 70 feet with drifts from the bottom. These pits are worked during cold weather only and can not be operated a second season, as the walls cave in badly during wet weather. New pits are sunk each season at a safe distance from the old pits. With better facilities for handling the water encountered in the pits the work could be carried deeper, to the most valuable "akik" beds immediately beneath the conglomerate bed, which would probably be sufficiently firm to form a good roof for the galleries.

The agates fresh from the mines are light colored and generally have a slight milky tinge. The colors are brought out and intensified by baking, by which the maize-colored stones gain a rosy tint, the darker yellow varieties become pinkish purple, the orange-colored stones become red, and the cloudy brown and yellow banded agates become red and white. Pure white agates are rare. The red carnelians range in tint from the faintest flesh color to the deepest blood red. The best stones are those of a deep clear even red color and free from flaws. The agate pebbles are chipped when mined and again after baking to determine their quality and value.

The carnelian deposits of this region have been worked for more than four hundred years. The stones were cut and worked into such ornaments as cups, vases, knife handles, beads, etc., at Limodra, in the earliest times. This industry was transferred to Cambay during the seventeenth century and has continued there until the present time. The carnelians are still baked and sorted at Limodra. The production of carnelian and agate during the five years from 1902 to 1906, as reported to the Geological Survey of India, amounted to 100,000 cubic feet, or 20,000 cubic feet annually. The production recorded during the five years ending in 1878 was valued at £7,000 annually.

AMETHYST.

NEW JERSEY.

According to Mr. Frederick A. Canfield, of Dover, N. J., about a dozen amethyst crystals found at Paterson, N. J., were cut during 1909. These yielded stones ranging in weight from 1 to 3 carats.

MARYLAND.

Prof. A. Bibbins, of the Woman's College, Baltimore, has called attention to the recent discoveries of amethyst crystals at Granite, Baltimore County, Md. Some of the crystals are reported to have yielded very good gems.

APOPHYLLITE.

NEW JERSEY.

Mr. Frederick A. Canfield, of Dover, N. J., reports the collection of about a quarter of a pound of rich brown apophyllite crystals with a fine white chatoyant luster. This apophyllite came from the new Erie Railroad cut through Bergen Hill, N. J. Mr. Canfield believes the specimens would make good cat's-eyes if properly cut.

BENITOITE.

CALIFORNIA.

An excellent description of the new California gem mineral, benitoite, has recently been given by G. D. Louderback, of the University of California.[a] The locality was visited during the summer of 1909 by the present writer, and every facility was given for the examination of the deposit by the Dallas Mining Company through the kindness of Mr. Thomas Hayes, at that time acting superintendent. The following description has been abstracted in part from Doctor Louderback's report and notes supplied from personal observation have been added.

The difficulty mentioned by Doctor Louderback in learning who was the original discoverer of the benitoite property was encountered by the writer. It is evident that J. M. Couch, of Coalinga, grubstaked by R. W. Dallas, was instrumental in finding the deposit. Whether he discovered it while out alone or on a second trip with L. B. Hawkins, of Los Angeles, is a point in dispute. Material taken to Los Angeles by Mr. Hawkins was pronounced volcanic glass and valueless. According to Mr. Couch, specimens given to Harry U. Maxfield, of Fresno, were shown to G. Eacret, of Shreve & Co., San Francisco, and to G. D. Louderback. Specimens cut by Mr. Eacret were thought to be sapphire. Doctor Louderback found the material to be a new mineral and named it benitoite [b] after the county in which it was found.

The benitoite mine is in the southeastern part of San Benito County, near the Fresno County line. The deposit is about 35 miles by road northwest of Coalinga in the Diablo Range, about three-fourths of a mile south of Santa Rita Peak, and on one of the tributaries of San Benito River. The elevation of the mine is about 4,800 feet above sea level; the elevation of Santa Rita Peak is 5,165 feet. The mine is in the end of one of the branching ridges from the south side of Santa Rita Peak. The end of the southward extension of this ridge is a low knob about 160 feet above the creek. This knob is called the apex, and from it a small spur extends to the west down to the creek. The benitoite mine is in the south side of this spur, about 50 feet lower than the apex and 250 feet west of it.

The benitoite deposit occurs in a large area of serpentine which extends many miles northward past the New Idria quicksilver mine and a few miles southward, and forms the summit of an anticlinal ridge pitching down to Coalinga. This serpentine is of the usual type of the Coast Ranges and presents different phases from hard dark-green and greenish-black material to softer lighter-colored rock containing more or less talcose and chloritic minerals. Slickenside seams and lentil-shaped blocks and masses are common through the serpentine, much of which is decomposed near the surface and breaks down to light grayish-green soil which has a greasy feeling when rubbed between the fingers. Inclusions of masses of schists and other rocks of the Franciscan formation occur in the serpentine. These

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[a] Louderback, G. D., and Blasdale, W. C., Benitoite, its paragenesis and mode of occurrence: Bull. Dept. Geology Univ. California No. 23, vol. 5, December, 1909, pp. 331-380.

[b] Louderback, G. D., and Blasdale, W. C., Benitoite, a new California gem mineral: Bull. Dept. Geology Univ. California No. 9, vol. 5, July, 1907, pp. 149-153.

schists may be micaceous or more basic, having common hornblende, actinolite, or glaucophane as characteristic minerals.

The benitoite deposit is located in one of these basic inclusions, a portion of which has a somewhat schistose structure, while the rest is nearly massive. These phases were probably originally different adjacent formations that have been metamorphosed. Part of the massive form is a dark-gray to greenish-gray rock that might be called trap. In some specimens the following minerals are determinable under the microscope: Augite, plagioclase crushed and recrystallized and containing clinozoisite prisms, secondary albite, yellow serpentine, and a little titanite and pyrite. The rock is therefore a partly metamorphosed diabase or gabbro. The more schistose phases are grayish-blue to blue and grade into vein material. They are composed of one or more varieties of hornblende, some partially chloritized, with albite, and, near the vein, with natrolite. The hornblende occurs in minute needles, felted masses of needles, blades, and stouter prisms. These have a bluish to yellowish green to nearly colorless pleochroism, and are in part probably actinolite and in part glaucophane or allied hornblende. The natrolite fails and the albite is also less abundant in the hornblende rock at some distance from the vein.

The vein is a highly mineralized shattered zone in the schistose rock. The fractures and joints with the vein filling are about parallel with the schistosity of the rock, which averages nearly east and west in strike with local variations and has a varying dip of 20° to 70° N. A sketch map of a small area on the benitoite mine hill giving the outcrops with their dips and strikes and the formations encountered in the mine workings shows the schist and gabbro inclusion in the serpentine to be quite irregular in shape. The width at the mine between the serpentine walls is about 150 feet and at a distance of 150 feet east of the mine it is only about 90 feet; about 80 feet farther east at the apex it is over 100 feet. This schist inclusion has been described by Ralph Arnold [a] as 150 feet wide at its widest point and at least 1,200 feet long.

The metamorphism of the schist inclusion has been of two kinds—first mashing and sheeting of the original basic rock producing schistosity and opening channels for solutions and then a passage of mineral-bearing solutions recrystallizing and replacing the minerals of the rock with albite. The albite permeated the rock for many feet each side of the fracture zone. The conditions of temperature or pressure of the solutions became changed, so that natrolite was next deposited. The natrolite did not permeate far into the rock, but formed a coating on the walls of the fissures. Neptunite and benitoite were formed with the natrolite at this stage in the fissures and openings but did not penetrate the wall rock. This whole mineralized zone containing many bands and masses of natrolite with gem minerals in the joints, fissures, and open spaces in the brecciated hornblende rock may be called the vein.

The unfilled cavities and seams in the vein zone aided by later fractures and faults has offered an easy passage for more recent decomposing meteoric waters. The latter have leached portions of hornblende schist along and included in the vein, have removed part of the minerals of the vein, and have stained the natrolite on

[a] Science, new ser., vol. 27, 1908, pp. 312-314.

the walls of the cavities and seams with iron and manganese oxides. The rock, leached of albite, has a more or less porous texture and is composed principally of fine fibrous blue hornblende and actinolite.

Development work at the benitoite mine at the time of the writer's visit consisted of a large and a small open cut, a prospect drift or tunnel with a crosscut tunnel, and an incline shaft. The large open cut or "glory hole" was 20 to 45 feet wide, 85 feet long, and from a few feet to 35 feet deep; it had a north of east direction into the hillside. The smaller open cut was to the north side of the entrance of the larger cut and at a lower level, it was about 60 feet long and 10 to 15 feet deep. The prospect tunnel was driven 120 feet in a direction N. 70° E. from the end of the large open cut. The crosscut tunnel was 45 feet long and driven to the north at a right angle from the main tunnel at a distance of 50 feet from the mouth. The incline shaft was sunk 35 feet deep from the north side of the open cut at about the middle.

The prospect tunnel cut through the hornblende schist formation into decomposed serpentine. The contact was evidently a fault line, and near it the serpentine contained much talcose and scaly asbestiform material. The fault was directly across the schistosity with a north-south strike and a dip of 45° W. This prospect tunnel encountered a little natrolite (vein material) in the hornblende schist in its upper west side, 15 feet beyond the crosscut tunnel, which crossed a small streak of vein material containing a little benitoite about 10 feet from the main tunnel. Vein material formed the roof of the prospect tunnel for several feet near its mouth. The "glory hole" was excavated in a very large pocket or bulge in the vein, a portion of which may still be seen along the north wall of the open cut. The incline shaft was apparently sunk in the lower part of this outcrop and did not encounter benitoite. The smaller open cut exposed vein material with benitoite, which was more plentiful near the east end of the cut than at the west end. The vein and the schist in this cut were much blackened and stained with films and seams of manganese dioxide. About 30 feet S. 60° E. of the upper end of the large open cut a ledge of altered blue hornblende schist outcrops prominently. This ledge also carries a streak of natrolite with benitoite. Benitoite has been found in bowlders a few hundred yards west of the mine on the hillside and in the creek. These bowlders have evidently rolled from the outcrop on the hill above and probably from near the mine. Doctor Louderback states that benitoite has been found for a distance of about 230 feet at the surface along the mineral zone and in very small quantity at its extremes. The writer observed benitoite in place through a distance of about 170 feet in an east and west direction.

The strike of the ledge outcropping to the east of the open cut was about N. 60° W., with a high northerly dip. The strike encountered in the tunnel, about 30 feet lower and to the north, was nearly east and west with a dip of about 40° N. In the upper part of the face of the open cut the dip was high, about 65° N., and below the middle of the face it was low, 15° to 25° N. Along the north side of the open cut and in the lower cut the strike was about east and west and the dip was probably rather low, 20° to 30° N. These measurements do not agree closely with those of Doctor Louderback, especially in regard to the dip of the vein. Jointing of the rock and the irregular nature of the vein, however, make accurate measurements difficult. Doctor Louderback places the dip at 65° to 69° N., but the dip measured by the writer is much lower, probably 15° to 30° N. in the lower part of the cut. The evidence for this measurement is found in the position of the vein at the outcrop and in the tunnel, of the layers of blue schist and natrolite in the end of the cut, and of the ledge along the north side of the open cut and in the lower cut. Such a low dip would account for the failure of the incline to cut the mineralized zone. The failure might also be due to the pinching out of the vein a short distance below the large pocket opened in the "glory hole." The impression gained by a study of the deposit and by plotting the location of the vein where encountered in different places was that the deposit consists of an ore shoot pitching to the west and lying in a fracture zone in hornblende schist with an irregular east and west strike and north dip. This shoot had a lenticular cross section with a thickness of more than 25 feet in the thickest part but pinching out on the sides. The upper edge of the shoot has been removed by erosion. A portion of the lower edge was encountered in the tunnel. The eastern extension of such a shoot would have been removed by erosion and the western extension would be underground, to the north of, west of, and below, the open cut.

Doctor Louderback mentions the outcrop of spheroidal gabbro on the southeast of the benitoite deposit on the hillside. The outcrop of rock on the north side of the vein zone, on the summit of the ridge, is of a similar nature and has been mentioned above as diabase or gabbro. The same rock was encountered in the crosscut tunnel 40 feet below the surface and 30 feet north of the main tunnel. Underground this rock occurred in large loose spheroidal bowlders ranging up to several feet in thickness, with large openings between them. This material was difficult to mine and required careful timbering. The open spaces evidently extended to the surface above, as a strong draft of air came through them. The spheroidal shape of the blocks and the open spaces between them were doubtless formed by decomposition and leaching along fracture planes.

The benitoite occurs with neptunite in crusts, seams, and thicker deposits of white natrolite on the walls of geode-like cavities and fissures in the hornblende schist. These deposits occur in both irregularly shaped masses and in seams with more definite directions. They inclose fragments of hornblende schist which has been heavily impregnated with natrolite. In some of the inclusions the gradation from the hornblende rock containing much natrolite to natrolite containing acicular inclusions of hornblende is complete. The benitoite is embedded in or attached to natrolite, being in some places completely, in other places partly, enveloped by it. In the latter places the benitoite projects into the cavities along with the coarse drusy surfaces of the natrolite. Natrolite with or without benitoite and neptunite fills some of the fissures and former cavities completely. The benitoite is always in contact with natrolite and has not been found embedded in the hornblende rock alone. It is in many places attached to hornblende impregnated with natrolite and is partly or completely inclosed in natrolite on the remaining sides. The neptunite is subject to the same relations with the natrolite and is, in places, partly surrounded by benitoite. These facts point to the same period of formation for the three minerals with the power of crystallization arranged in the following order: neptunite, benitoite, and natrolite.

The benitoite is obtained by breaking open masses of vein rock and carefully chiseling or working the crystals out of the inclosing natrolite. Many gems are injured or ruined by this method. The removal of the natrolite by acid has been tried with partial success. Large slabs of rock 2 to 3 or more feet across are obtained coated with natrolite and carrying benitoite and neptunite. The last two minerals are either visible on the drusy surface of the natrolite or are completely covered by natrolite. The position of the benitoite and neptunite is often marked by lumps or a thickening of the natrolite crust. By carefully cutting into these lumps beautiful crystals are sometimes uncovered. Often the inclosing crust or shell of white natrolite can be split from a crystal of neptunite or benitoite in two or three large pieces, so that the covering can readily be replaced over the crystal. Such material makes beautiful specimens. Slabs of bluish hornblende rock with a drusy pure white crust of natrolite containing brilliant reddish-black neptunite and blue benitoite in fine crystals are excellent for the same purpose.

The minerals associated with benitoite are described and analyses are given in the paper of Louderback and Blasdale. Neptunite is titanium silicate containing iron, manganese, potassium, sodium, and magnesium. It occurs in black to reddish-black prismatic crystals of the monoclinic system, the length commonly being several times the thickness. It has a prismatic cleavage and the thin splinters or powder show a deep reddish-brown color. The hardness is between 5 and 6 and the specific gravity 3.18 to 3.19. Neptunite is practically insoluble in hydrochloric acid.

The natrolite, with which the benitoite and neptunite are associated, does not generally occur in distinct crystals of any size. It forms massive granular white aggregates of crystallized material with curved ridge-like or cockscomb-like groups of crystals and drusy botryoidal masses in the cavities. Natrolite is a hydrous silicate of sodium and aluminum crystallizing in the orthorhombic system.

Other minerals occurring in smaller quantity in the cavities are emerald-green copper stain, amphibole needles, albite, aegirine, and psilomelane. The amphiboles are actinolite, a variety intermediate between crossite and crocidolite, and a little glaucophane.

The chemical and physical properties of benitoite and its associated minerals have been described by Louderback and Blasdale,[a] and the following notes are taken from their description. The chemical analyses show it to be an acid barium titano-silicate corresponding to the formula $BaTiSi_3O_9$. Benitoite is insoluble in ordinary acids, but is attacked by hydrofluoric acid and dissolves in fused sodium carbonate. Alone, it fuses quietly to a transparent glass at about 3. The color of benitoite is not affected by heating the stone to redness and allowing to cool. The hardness is greater than orthoclase and less than peridot, or about $6\frac{1}{4}$ to $6\frac{1}{2}$, and the specific gravity is 3.64 to 3.67

Benitoite crystallizes in the trigonal division of the hexagonal system. The common forms observed are the base c(0001), trigonal prisms m($10\bar{1}0$), and n($0\bar{1}10$), and the trigonal pyramids p($10\bar{1}1$) and π($0\bar{1}11$). Other forms are rather rare and of small importance.

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[a] Bulls. Dept. Geology Univ. California Nos. 9 and 23, vol. 5.

Of these faces the pyramid π generally has the largest development. This gives the crystal a triangular aspect with the corners truncated by smaller planes. The prism faces are narrow, though generally present. Many of the crystals are naturally etched on one or more sets of faces. Such faces are a little dulled or slightly pitted. Benitoite has an imperfect pyramidal cleavage and a conchoidal fracture.

The mean refractive index of benitoite is greater than that of sapphire, and measures 1.757 to 1.804 (sapphire 1.759 to 1.767). The birefringence is high and the pleochroism very strong. The crystals are generally transparent with a pale to deep-blue and bluish-violet color. Color variations are common in the same crystal, and the change from dark to light blue or colorless may be sharp or gradual. The pleochroism of benitoite is pale to dark-blue or purplish and colorless. The richest colors are seen when the crystals are viewed parallel to the base. The intensity of the blue diminishes as the light ray penetrates the crystal at other angles until perpendicular to the base, when the crystal is colorless. Care is necessary, therefore, in cutting the gem so as to secure the best effects. Pale-colored stones should be cut with the table perpendicular to the base or parallel to the vertical axis of the crystal to secure the full color value. Deeper-colored stones may be cut in the same way or with the table in an intermediate position, if the color is very strong. By cutting intensely colored stones with the table only slightly out of parallel to the base, the color may be reduced to a desirable shade. The dichroscope may be used to determine the position of the vertical axis and accordingly of the base perpendicular to it. When viewed perpendicular to the vertical axis with a dichroscope the twin colors or two rays of light are very intense to pale blue (depending on the depth of color of the crystal) and colorless. When viewed parallel to the vertical axis, or perpendicular to the base, the two rays are colorless and remain so while the dichroscope is rotated. The color of one of the rays becomes stronger as the crystal is rotated from this position. Benitoite crystals exhibiting two shades of color, as dark and light blue or blue and colorless in different parts of the same crystal, may be cut so as to show these variations, or sometimes in such a way that the resulting color is of nearly uniform intensity.

Benitoite has been cut as a brilliant, with the step or trap cut, and "en cabochon." The brilliant cut is especially suitable to show the brilliancy and fire of the gem. The brilliancy is due to the high refractive index and the fire or red flash, often seen in dull or artificial light is, in part at least, caused by the dispersion of the mineral. Of the colors produced by dispersion during the refraction of light in benitoite yellow and green are largely absorbed in the colored gems so that principally red and violet-colored lights are seen. These flashes of colored lights along with the natural fine blue of benitoite render the gem particularly beautiful. The step cut displays the color of benitoite to advantage, with only slight loss of brilliancy. Cabochon-cut gems from crystals with color variations or partially flawed material have some beauty.

The size of the gems cut from benitoite range in weight from a small fraction of a carat to several carats. According to Doctor Louderback the largest perfect stone so far cut weighs over 7 carats and is about three times as heavy as the next largest flawless gem so far obtained. The majority of larger cut stones weigh from $1\frac{1}{2}$ to 2 carats. The principal production is in stones weighing less than $1\frac{1}{2}$ carats.

The use of benitoite in rings or jewelry subjected to hard wear is limited by its comparative softness. The beautiful color, brilliancy, and fire of the gem, however, adapt it to other classes of fine jewelry. Since the supply of benitoite is thought to be limited and a fairly large demand has already arisen for the gem, it is probable the price will be kept high, possibly as high as that of sapphire, its nearest rival in color.

So far benitoite has been found at one place only. J. M. Couch, one of the original discoverers of the benitoite deposit, has located several prospects in formations resembling that at the benitoite mine. In one of these, three-fourths of a mile to the north on the east side of Santa Rita Peak, cavities lined with natrolite crusts and crystals have been found in a bluish hornblende schist rock very similar to that at the original mine. The schist near the vein is composed of bluish hornblende and actinolite needles penetrating granular masses of albite. This rock also incloses crystals of natrolite showing that part of it was formed later than or during the crystallization of the natrolite. In the cavities the natrolite occurs in simple well-developed white columnar crystals up to a centimeter or more in thickness and several times as long. Neither benitoite nor neptunite have been found associated with this natrolite.

BERYL.

MAINE

Dr. O. C. Farrington, of the Field Columbian Museum, of Chicago, reports the purchase of a crystal of golden beryl from Poland, Me., by the museum. The crystal is hexagonal in form and measures $2\frac{1}{2}$ by 1 inch. The purchase price was $60.

Mr. Alfred W. Smith, of the Maine Feldspar Company, Auburn, Me., reports the sale of large beryl crystals and fragments for commercial purposes. This material was not suitable for gems, but was used in the chemical industry. The beryl was obtained during mining for feldspar.

COLORADO.

Mr. J. D. Endicott, of Canon City, Colo., operated the aquamarine deposits on Mount Antero, Colo., during 1909, with some success. Some good gem material and many good specimens were obtained. The deposits have been worked more actively during the open season of 1910 and much fine gem material has been obtained.

CALIFORNIA.

Mr. A. W. Pray, of Escondido, Cal., reports a production of about 20 pounds of white beryl and aquamarine crystals from the Hercules mine, near Ramona. Some of this material is well suited for cabinet specimens, especially that associated with crystallized albite feldspar.

It is reported that the San Diego Company, of San Diego, Cal.,[a] has cut a number of fine beryl crystals. The largest, a pink stone, weighs over 26 carats and is valued at about $400. Other gem

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[a] Jewelers' Circ. Weekly, April 6, 1910.

beryls cut were blue, white, and yellow, few green stones having been found on the company's property.

MADAGASCAR.

Morganite, a rose-colored beryl.[a]—In a paper read before the New York Academy of Sciences on December 5, 1910, Dr. George F. Kunz described some new and remarkable gems which had been cut from a rose-colored beryl found in Madagascar. He proposed the name "Morganite" for them in honor of J. Pierpont Morgan, of New York City.

The beryl, together with other gem minerals, is found at Maharita in the valley of the Sahatony, an affluent of the Manandora which passes along the western slope of Mount Bity, Madagascar. The minerals occur in numerous veins of pegmatite which penetrate the alternating layers of limestone mica schist and quartzite. The veins are often nearly 100 feet thick and consist of quartz, amazonite often in fine colors, albite, lithia, tourmaline, lepidolite in deep shades, etc. In these veins magnificent crystals of tourmaline, beryl, and kunzite have been found.

The pink beryl—morganite—has also been found associated with kunzite at Pala, San Diego County, Cal., in large but pale crystals that are sometimes more of a salmon color. At the Madagascar locality, however, it was found in magnificent specimens of gem quality, some of which weighed 98½ carats. Its color is a true rose-pink, a pure, clear color, with less of the magenta tint than is found in even a pale tourmaline and lacking the lilac of the kunzite. It is obtained in larger, finer stones than any other pink gem. When exposed to the Roentgen rays the new beryl assumes a brilliant cerise color under a tube of moderately low vacuum with about 12 or 15 amperes through the tube. When the current is increased the brilliancy of the stones increases accordingly. Under the mercury light it becomes a pale lilac.

This beryl was found by Ford[b] to contain 4.98 per cent of alkalies distributed as follows: Na_2O, 1.60; Li_2O, 1.68; Cs_2O, 1.70. Along with this unusual amount of alkalies goes a slightly higher specific gravity (2.79) and an increase in the mean refreactive index and in the amount of birefringence.

CALIFORNITE (VESUVIANITE).

The massive compact form of vesuvianite, named californite by George F. Kunz[c] has been found at several localities in California. Among these are the Happy Camp region, in Siskiyou County; near the Hawkins schoolhouse and near Selma, in Fresno County; near Lindsay and near Exeter, in Tulare County; and at two points along the Feather River near the Butte-Plumas County line. The Siskiyou and the Fresno County localities have been described or mentioned by Doctor Kunz, and notes on the locality near Exeter were furnished by Frank L. Hess, of the United States Geological Survey, for this report of 1906. The californite deposit in Siskiyou County belongs

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[a] Am. Jour. Sci., 4th ser., vol. 31, 1911, p. 81.
[b] Am. Jour. Sci., 4th ser., vol. 30, 1910, p. 128.
[c] Gems, jewelers' materials, and ornamental stones of California: Bull. State Min. Bur. California No. 37, 1905, pp. 93–95.

to D. C. Collier and S. F. Smith, of San Diego. This locality was visited during 1910 and will be described in the report for that year. The mine near Hawkins schoolhouse in Fresno County has been taken up by the Southwest Turquois Company, of Los Angeles. Part of the californite from Fresno County has been cut by the Jupiter Consolidated Jewel Company, of Los Angeles. The prospect near Lindsay, Tulare County, belongs to C. M. White, of Lindsay, and is described below.

The californite from different localities and different specimens from the same deposit differ in color. The better material from the Collier-Smith mine is translucent gray and green, with bright green spots through it, and portions of this californite are nearly bright grass-green. The gem californite from the Southwest turquoise mine has a grass to olive green color; some of it inclines to lemon color and has bright emerald green spots through it. Californite from some of the localities varies from bright green to white and translucent gray or nearly colorless. Specimens in the possession of George C. Mansfield, of Oroville, from the Feather River localities, vary from green to white, and some are nearly colorless and transparent. A cut stone of the transparent material very much resembles moonstone, but there is a possibility that it may be massive white lime garnet, similar to that from the Fresno County californite locality. This material is described by Clarke and Steiger[a] as white and massive, somewhat resembling chalcedony. Specimens of a similar pure white mineral with texture and physical properties like those of californite or jade, have lately been received from Mr. A. Clausen, of Happy Camp, Cal. This mineral was obtained from a bowlder in Indian Creek. It is not possible without a quantitative chemical analysis to state whether it is massive white garnet or vesuvianite.

Californite greatly resembles jade in color, hardness, toughness, texture, and specific gravity, and when first discovered was mistaken for jadeite. It doubtless would be used more largely for this mineral by the Chinese if obtained in larger flawless blocks. A large portion of the californite from some of the deposits is so divided by joints and partings or checked by flaws that it is difficult to obtain specimens that could be used for carving into larger ornaments as bracelets or works of art. The rich color, translucency, and hardness of the mineral, however, render it very attractive for ring or scarf-pin stones, beads for necklaces, etc.

The californite deposit of C. N. White was found in a copper prospect about 6 miles east of Lindsay. Nearly a dozen small openings were made on the south side of the ridge south of Lewis Creek at elevations of 300 feet to 500 feet above the plains to the west. The country rock is serpentine, cut by a dike of hornblende schist. The serpentine is grayish to greenish-black and considerably broken by joints and slickensides. Magnesite seams ranging in thickness from a fraction of an inch to 2 inches cut the serpentine at all angles. White cherty silica or chalcedony seams occur with the magnesite in places. The hornblende schist does not outcrop strongly, though the strike is apparently west of north. It is a fine-grained nearly black schistose rock, composed of green hornblende and plagioclase feldspar. Californite has been found in several of the openings along

[a] Clarke, F. W., and Steiger, George, On "californite:" Bull. U. S. Geol. Survey No. 262, 1905, pp. 72–74.

with small amounts of copper minerals as chalcocite, malachite, and azurite. The green californite grades into pale gray and white material of evidently the same substance, with a pinkish color where bordering on dark greenish serpentine inclusions. Blocks of this material as large as 2 feet across were seen, and slabs with this pleasing combination would yield very handsome ornamental stones for table tops, etc. The best colored californite is nearly grass-green and translucent. Specimens of the lighter-colored and gray varieties have bright emerald-green spots through them. These green patches chipped from the rock were found to contain chromium, which is, therefore, doubtless the pigment giving the green color. Under the microscope in thin section californite is colorless, has a fairly high refractive index, contains only a few minute inclusions of short needles, and varying amounts of specks of a highly birefringent mineral, probably magnesite. Between crossed nicols the birefringence is low, giving a dull greenish-brown color. The mass is composed of numerous close-fitting and interlocking irregularly shaped grains of this peculiar birefringent material. These grains extinguish at all angles as the section is rotated. The exceeding toughness of the californite variety of vesuvianite is doubtless due to this peculiar interlocking granular texture of the mineral. Vesuvianite grains are scattered through serpentine and through magnesite grains and masses, and there seems to be a gradation from masses of one to masses of the other.

CHLORASTROLITE.

Mr. S. W. Barton, of Chicago, Ill., reports a considerable collecting and polishing of chlorastrolites by and for the summer tourists along the shores of Isle Royale, Michigan, but according to Dr. Alfred Lane the quantity found is diminishing and the quality of the chlorastrolite gems is poorer than formerly. Mr. Barton states that he has also found chlorastrolites halfway between the town of Avitonogan and Porcupine Mountain, Michigan, on the beach on the shore of Lake Superior, near the town of Lake Linden in a stream, and in the copper mines at Mandan.

CHRYSOPRASE.

CALIFORNIA.

Chrysoprase has been mined at several places in Tulare County, Cal. The largest operations have been those of the Himalaya Mining Company, of New York. This company has opened mines 8 miles southeast of Porterville, three-fourths of a mile due north of Lindsay, on Venice Hill 8 miles east of Visalia, and at other points. A. A. Prim, of the Franklin Playter Company, of Boston, operated a chrysoprase mine on Venice Hill, adjoining the Himalaya mine. On a small knob one-half mile north of east of Plano a prospect has been opened by A Brooks. This produced mostly chrysopal and common opal. At time of examination all of these mines were idle. The mine of the Himalaya Mining Company near Porterville was only temporarily closed and that of the Franklin Playter Company on Venice Hill had been closed only a few months. The other mines mentioned have not been operated for several years.

The occurrence of chrysoprase at the different mines is very similar. All of the mines are located in hills which are more or less rough and rocky on their upper parts and whose lower slopes pass into the plains or prairie country at their base. These hills rise from 150 to 350 feet above the surrounding country and belong to the first range of foothills of the Sierra Nevada Mountains.

The country rock for the region is serpentine, which is not homogeneous in nature. Different types of basic rocks have apparently been metamorphosed to serpentine, and in some places this metamorphism has not been complete. The serpentine has been more or less weathered so that it is sometimes not readily recognized. Other types of rock occur but are not important near the chrysoprase deposits. Red and brown jasper-like or cherty rock is prominent at each mine and appears to be more or less directly associated with the chrysoprase deposits. This rock forms the rough outcrops so prominent on all the hills containing chrysoprase mines. These jasper or chert masses are irregular in shape and appear to be segregations in the serpentine. They grade into serpentine and in thin section under the microscope are seen to be composed of shattered serpentine more or less replaced by and firmly cemented together with chalcedony, quartz, and opal. The serpentine fragments inclose and are surrounded by particles of iron oxide, chiefly limonite. The serpentine around many of these jasper segregations is more or less decomposed.

The chrysoprase occurs in seams and veinlets in the jasper rock and serpentine. In many places it is associated with chalcedony veinlets and veins. The chalcedony is associated with finely granular crystalline quartz, and these two give place to chrysoprase where the necessary green nickel stains have been absorbed. The chrysoprase consists of chalcedony with a fibrous spherulitic texture grading into fine crystallized quartz with a staining of green nickel salt in the interstices. Some chalcedony can not be distinguished from finely crystallized quartz without the use of a microscope, and as the two are here closely associated the term chalcedony is used to cover both. Common opal in some quantity occurs in the serpentine and jasper formations in veinlets and seams very similar to the seams of chalcedony. Some of it is stained green with nickel and is called chrysopal. Some of the seams and veinlets of chalcedony and opal with their associated chrysoprase and chrysopal occupy regular joints or fissures in the rock and can be traced many yards; others are continuous for a few inches only. The veinlets range in thickness from a fraction of an inch to two or three inches. Larger veins occur but are not often solid chalcedony or chrysoprase. They generally contain more or less chert or jasper filling, with horses or inclusions of wall rock. Magnesite occurs in seams and veinlets in the fresh decomposed serpentine.

The association of the jasper masses with decomposed serpentine at numerous localities indicates a genetic relation between these two. The weathering of serpentine results in free silica, and it is possible that the latter in solution has impregnated portions of the rock along fracture zones and filled joints and seams. Where impregnation has taken place and iron stains were present hard jaspery masses of rock were formed. In the joints the free silica would form chalcedony, quartz, or opal, and if iron oxides were present in quantity, jasper might be produced. Solutions carrying nickel obtained from the serpentine would add the necessary coloring to produce chrysoprase and chrysopal. Since silica is set free during the alteration of the original basic igneous rocks to serpentine, part or all of the silicification of the serpentines into jasper-like masses and the formation of chalcedony and opal veins may have taken place during the original formation of the serpentine. The gradation of chalcedony and chrysoprase veins into silicified serpentine and jasper wall rock indicates that they were formed at essentially the same time.

Mining for chrysoprase in California is generally confined to open work. Where shafts and tunnels have been made they are not deep. The walls of the workings are subject to caving or sliding along slickenside seams sometimes present. Around some of the chrysoprase deposits are shallow pits or depressions and small dumplike mounds which resemble the ancient workings of the Aztecs seen around the turquoise mines of the Southwestern States.

The quality of the chrysoprase ranges from poor to the finest, depending on the purity and texture of the chalcedony and quartz and the depth of the green nickel stains which give the color. The finest gem chrysoprase is highly translucent, with a rich emerald or grass-green color evenly distributed throughout. Such material is often found associated with pale and nearly opaque chrysoprase, grading into translucent gray and white chalcedony and quartz. The nickel-stained opal, chrysopal, sometimes rivals the best chrysoprase in color, but is not so valuable, as it is softer and quite brittle.

The first work on the chrysoprase deposits of Venice Hill is said to have been done by Jerome Prethero and R. V. Methvin, of Visalia, more than fifteen years ago. These men were prospecting for copper, of which the green nickel stains were thought to be an indication. The land was owned by Abe McGinnis as a ranch and was next leased to L. Tannenbaum to be mined for chrysoprase. Later a portion was sold to Tannenbaum and the remainder of the gem-bearing portion to the Franklin Playter Company.

The locality called Venice Hill is composed of a small group of hills rising from 100 feet to over 300 feet above the surrounding plains. This group of hills is more than 2 miles long in a north and south direction and about 1 mile wide. There are two prominent hills about a mile apart, with minor ridges and knobs around them. The chrysoprase mines are on the southeast slopes of the northern hill and about 600 yards apart. The Franklin Playter mine is south of the Himalaya mine and about 100 to 150 feet lower. The country rock on the northern part of Venice Hill is principally serpentine, not homogeneous in composition, with large irregular masses of cherty rock. The serpentine is badly decomposed in places; one portion is still hard and resembles a partly altered trap rock. A large irregular ledge of quartz nearly 100 feet wide outcrops on the western slope of the hill with an east of north trend. The jasper or chert rock masses form hard rugged outcrops on the summits and ridges and in places have veinlets of quartz, chalcedony, or opal associated with them. At one place on the main ridge, west of the workings of the Franklin Playter mine, there was a small hole of unknown depth called "the crater hole" and locally thought to be of volcanic origin. Veinlets of chalcedony and chrysoprase are reported to have been found extending from this hole outward.

This hole may represent a solution channel, but it may equally well be considered the work of ancient miners. Possible evidence of aboriginal mining may be seen in other small depressions and accompanying dumps on Venice Hill.

Franklin Playter mine.—The Franklin Playter chrysoprase mine has been opened by nearly a dozen open cuts with some tunneling and a shaft 30 feet deep. Some of the cuts are merely trenches or crosscuts; others range up to 25 by 50 feet by 20 feet deep. The serpentine country rock gives place here and there to large bodies of red, brown, and yellowish jasper or chertlike rock. This serpentine is not homogeneous in texture or color and in places is badly decomposed and stained with iron oxides. Small seams of magnesite occur in portions of the serpentine as a filling of joints and fissures. Veinlets and seams of chalcedony and opal, with or without nickel stains, cut the rock in various directions. Some of the veinlets prominent in the workings have a northeast trend, though gem material is not confined to them. Chrysoprase and chrysopal veins and seams occur in both the serpentine and the jasper or chert rocks, but they are more plentiful in or near the latter. The jasper and chert masses are very irregular in shape and some of them are not continuous with depth, for the mine workings have been driven under bodies of this rock several feet across.

In one of the principal workings a streak, 2 or 3 feet thick, of scaly talc, with probably some deweylite and soft claylike material was exposed. A large amount of green nickel stain and a vein of common opal, several inches thick, without chrysoprase, was also found in this streak. This common opal varies in color from colorless to white, yellow, greenish, and black, and is of no value. The greater part of the other openings were on hard jasper or serpetine rocks, and some of them encountered both chrysoprase and chrysopal of fine emerald-green color. Gray and white chalcedony and opal veins are plentiful, and some with pale shades of green are not uncommon. The material in the veinlets is said to change abruptly from chalcedony to opal in places, and from the colorless or white varieties to rich green gem material. Indications of this were seen in hand specimens, which show changes both of mineral and of color. The veinlets are quite irregular in size and continuity. Some can be followed for many feet; others pinch out in a few inches. They range from a fraction of an inch to several inches in thickness, though the gem veins are rarely more than an inch thick.

Himalaya Mining Company mines.—The Himalaya chrysoprase mine on Venice Hill was worked by five open cuts ranging from 15 feet wide by 50 feet long and 5 to 20 feet deep to about 100 feet square. The country rock is serpentine, partly decomposed, with local developments of jasper or chert masses. The serpentine is cut at various angles by seams of magnesite, filling joints and cracks. Chrysoprase and chrysopal occur in veinlets and veins along with the associated chalcedony and opal. One prominent vein with an east of north strike and a west dip appears to be traceable through three of the open cuts. This vein is composed of jasper, chalcedony, and opal, with nickel stains producing chrysoprase locally. In places there is no chalcedony, only a jasper streak from a few inches to a foot thick. Other streaks of chalcedony and opal with chrysoprase have been followed in the workings, in places widening out to masses of milk-white opal 3 or more inches across. Veinlets of translucent colorless to pale-green chalcedony are common in the serpentine and chert masses. The change from chalcedony and chrysoprase to opal may occur within a few inches in the same veinlet. The jasper and chert outcrops on the hillside are very rough and irregular. They appear to be segregations in the serpentine, into which they pass by gradation. A microscopic section of the red jasper or chert rock shows it to be composed of numerous grains of a mineral with low birefringence, evidently serpentine, with chalcedony and opal seams and masses filling the interstices. The serpentine grains are both surrounded by veins of limonite and inclose much of it. The chalcedony has a coarse spherulitic texture in places. It acts as a siliceous cement, binding the rock into a hard, cherty mass.

The Himalaya chrysoprase mine near Lindsay is near the top of a rounded hill about 165 feet higher than the surrounding plains. This hill is elongated in a west of north and east of south direction. The mine openings are on the west and southwest side of the summit. The workings consist of two open cuts and a few smaller pits. One of the open cuts is U-shaped in plan and about 60 feet long by 15 feet deep in the deepest part. The hill is composed principally of serpentine, partly decomposed, with rough jasper or chert segregations. Smaller masses of actinolite rock and grano-diorite occur in the hill. The serpentine contains abundant magnesite seams in places. The cherty masses form very rough outcrops. The chrysoprase and the chrysopal occur with chalcedony and opal in seams and veinlets. In the opening some green nickel stains were found in the joints of the serpentine not associated with chrysoprase. Prominent joints or bedding occur in the serpentine parallel with the trend of the hill.

There are a few small pitlike depressions or holes and old dumps in or near the cherty serpentine outcrops on the south side of the hill. These resemble the workings of the Aztecs seen around ancient turquoise mines in the southwest. On the east side of the summit a bare floor of magnesite-seamed serpentine contains numerous rounded holes 6 to 10 inches across and 6 to 8 inches deep. These holes have evidently been made to serve the purpose of mortars for grinding grain either by the Indians or by earlier inhabitants. Several pestles of rounded elongated rocks of hard nature were found near the mortars.

It is reported that the Himalaya Mining Company also operated on a small scale for chrysoprase on a small knob about 1 mile southeast of this mine, or about three-fourths of a mile south of east of Lindsay.

The Himalaya chrysoprase mine, 8 miles southeast of Porterville, has been described in a previous report [a] from notes obtained by Frank L. Hess, of the United States Geological Survey. Additional notes were obtained by the writer during August, 1909, and are here combined with the former description. The mine is in a rough serpentine knob which rises some 350 feet above Deer Creek, half a mile to the north and about 200 feet above the plains on the west. The hill has a north and south elongation with a rough rocky summit. The lower slopes are smooth and pass into the grass-covered plains around the hill. The workings consist of three open cuts with other smaller pits on the southwest slope of the hill and a fourth pit on the

[a] Mineral Resources of U. S. for 1906, U. S. Geol. Survey, 1907, pp. 1216-1217.

west side. The main working is a slightly sinuous cut 180 feet long in a north and south direction and 5 to 15 feet deep. Two other cuts about 100 feet above this are 30 feet and 20 feet square, respectively, and 10 feet to 15 feet deep.

The country rock is chiefly serpentine, badly altered in places, with segregations of jasper-like or cherty masses. On the west side of the hill where one of the open cuts was made there is an outcrop of dense dark-greenish trap, probably a diabase partly serpentinized. The fresh serpentine is yellow, yellowish green, or green in color, and is compact. The decomposed serpentine is soft and more or less porous and in some places stained with iron and nickel. Both the fresh and the decomposed serpentine are cut at various angles by seams and veins of magnesite ranging in thickness from a fraction of an inch to 2 inches. The jasper-like masses are the usual red or brown hard, silicified serpentine. The whole summit of the hill is covered by hard, ragged outcrops of this rock, which in some places stand 20 feet above the surface of the ground. The rocks are cut by joints and seams of chalcedony, which have a northerly trend and a vertical to west dip. The veinlets of chalcedony range from a fraction of an inch to 6 inches thick and occur in both the chert and the serpentine. Veinlets of common opal and chrysopal are also found in the chert and the serpentine. Chrysoprase occurs, like the chalcedony, in veinlets and seams and may change into chalcedony within the space of a few inches. The best colored chrysoprase is not often found in veins over an inch or two in thickness. In prospect pits along the summit of the hill and on the north end little chrysoprase was found, though a small amount of good chrysopal was obtained.

Brooks chrysopal prospect.—The Brooks chrysopal prospect is on the east side of a small rounded hill half a mile north of east of Plano. A few small pits have been made around rough cherty serpentine outcrops. Common yellowish-green opal was found in considerable quantity in seams and veinlets cutting decomposed and cherty serpentine. Chrysopal of good color is reported to have been found. On the south side of the hill are numerous small pit-like depressions, with the remains of old dumps, which somewhat resemble ancient workings.

ARIZONA.

The blue and bluish-green copper-stained chalcedony from the Globe region, Arizona, described as blue chrysoprase in this report for 1907, is still being cut for gem purposes. This material comes from the Keystone and the Live Oak copper mines, about 6½ miles due west of Globe. The blue chalcedony, or "silicate" as it is locally called, was first taken out and a little was sold by Harvey and Finletter, the original owners of the Keystone mine. The gem material from the Keystone mine is now handled by the company owning the mine through the secretary, H. P. Wightman, of Globe, though some of it is surreptitiously removed from the mines each year by miners and sold to dealers in minerals and gems. The blue chrysoprase is obtained chiefly from the upper levels of the mines along with the other oxidized copper ores.

The Keystone and the Live Oak copper mines are located in a large area of granite with a porphyritic texture in place. In the Keystone mine the ore occurs along a fracture zone, filling seams and joints and replacing portions of the granite. The blue chrysoprase occurs in seams, veinlets, and globular masses, more or less closely associated with chrysocolla.

Much of the mineral is impure or contains numerous inclusions of the chrysocolla or fibrous radial bunches of malachite. The best blue chrysoprase is translucent pure chalcedony with a small amount of blue copper stain. This variety has a distinctive color in daylight and under lamp light possesses a green color very similar to that of regular chrysoprase. The very translucent variety makes a beautiful gem. The most common variety of the blue chrysoprase is cloudy blue and is translucent only on very thin edges. It may grade into the translucent variety or contain inclusions of malachite or chrysocolla. In some specimens this opaque variety is very dull and appears to grade into ordinary chrysocolla. This type of blue chrysoprase does not furnish an especially pretty gem, though a considerable quantity of it is cut. Very pretty cloudlike effects are obtained by cutting the stones with a mammillary or botryoidal structure in which the different layers of chalcedony have received varying amount of coloring matter and are translucent. This is especially noticeable when portions of the chalcedony are nearly clear and colorless. The poorer grade of blue chrysoprase with the associated chrysocolla and malachite would make pretty ornaments if larger pieces were cut and polished.

DIAMOND.

UNITED STATES.

Arkansas.—Conditions in the Arkansas diamond field have been well summed up by John T. Fuller,[a] consulting engineer of the Arkansas Diamond Company. Only slight progress was made in 1909 in developing the mines and prospects because of lack of capital. It is estimated that about 1,000 diamonds, weighing about 500 carats, have been found on the different properties. The outcrop of two peridotite bodies has been definitely determined; other possible occurrences of peridotite are being investigated. There are six properties held by incorporated companies and two by individuals. The Arkansas Diamond Company, the Ozark Diamond Mines Corporation, and M. M. Mauney own the peridotite area first discovered. The American Diamond Mining Company holds all of the second peridotite outcrop so far located. The Grayson McCloud Lumber Company owns a supposed peridotite outcrop at Black Lick. The Kimberlite Diamond Mining and Washing Company and the Ozark Diamond Mines Corporation hold two other supposed peridotite areas.

On the Arkansas Diamond Company property additional prospecting pits were dug to determine more carefully the area of the peridotite outcrop. In August a small diamond washing plant was erected. This consisted of a revolving sizing screen, an 8-foot rotary washing pan, a Hay jig, and a 20-horsepower boiler and engine. The plant was erected to study details for a larger plant with a capacity of 1,000 loads of 16 cubic feet per day of ten hours. At the date of writing (March, 1910), about 800 diamonds have been found according to

[a] Arkansas diamond fields in 1909: Eng. and Min. Jour., April 9, 1910, pp. 767–768.

Mr. Fuller. About 25 of these have been cut and found to be exceptionally fine. The cut diamonds, in an exhibition of some of the diamonds at Little Rock, Ark.,[a] are described as very brilliant, including several very fine blues, some pure whites, and two or three perfect canaries. Among the uncut diamonds is mentioned a pure white flawless half crescent shaped stone for which $125 per carat in the rough is said to have been offered by a New York dealer.

According to Mr. Fuller, prospecting with a core drill was carried on by the Ozark Diamond Mines Corporation on the eastern part of its property. It is believed that a peridotite dike about 100 feet wide with a north and south strike and 20 to 40 feet below the surface has been located. Very little work has been done on the company's property on the main area of peridotite. Nevertheless, about 75 diamonds have been picked up on the 8 acres on this area and the adjoining 2 acres of M. M. Mauney. Mr. Mauney has fenced in his holdings and charges an admission of 50 cents for visitors, who are allowed to search for and keep all diamonds found. The Kimberlite Diamond Mining and Washing Company has prospected its land 3 miles south of east of Murfreesboro by long trenches and shafts 20 to 40 feet deep; a large body of peridotite is claimed to have been located, though no diamonds have been reported.

An accurate description of the first peridotite formation in which diamonds were found, now largely owned by the Arkansas Diamond Company, has been given by George F. Kunz and Henry S. Washington.[b] These descriptions are an enlargement of an earlier description by J. C. Branner and R. N. Brackett,[c] with notes on the discovery of the diamonds. Since these articles were written there has been little new work of consequence and that has been outlined above from Mr. Fuller's article. It is not probable that new discoveries worthy of extended description will be made until the regular development of the mine is started. After the larger washing plant, now under way, has been completed and some thousands of loads of earth have been washed, the diamond content of the peridotite may be determined. Deep mining may bring out new relations between the peridotite and the country rock.

In Branner's report the southwestern one of the three knobs crossing the peridotite area is mapped as peridotite on the summit and part of the way down the west side. Kunz and Washington state that this knob is composed chiefly of Carboniferous sandstone. Along its summit is an outcrop of a hard ledge of bluish-gray rock resembling volcanic tuff, with a north and south strike and a nearly vertical dip. This rock contains angular inclusions of gray and dark-colored rocks, and has biotite scales through it. Chalcedony is present in seams and patches. When examined under the microscope a section showed chlorite, biotite, orthoclase, plagioclase, chalcedony, magnetite, garnet, and inclusions of a brownish isotropic material, probably glass. Such an agglomeration might pass as a volcanic tuff or breccia, but it might also be a contact zone between the peridotite and a graywacke,

[a] Jewelers' Circ. Weekly, April 6, 1910.

[b] Precious stones: Mineral Resources U. S. for 1906, U. S. Geol. Survey, 1907, pp. 1247-1251; and Trans. Am. Inst. Min. Eng., vol. 39, 1908, pp. 169-176.

[c] Am. Jour. Sci., 3d ser., vol. 38, 1889, pp. 50-59, and Ann. Rept. Geol. Survey Arkansas for 1890 vol. 2, 1891, pp. 377-391.

in which the latter was fractured and partly absorbed by the peridotite. The ridge farther west is composed of more typical quartzite, which forms hard ledge outcrops.

The occurrence of the peridotite at the mine of the American Diamond Mining Company's property, 3 miles south of east of Murfreesboro, was described by A. H. Purdue,[a] and an abstract given in this report for 1908. At the time of examination (July, 1909) the ground on and around the peridotite area at this mine was being stripped of vegetation to aid prospecting and development. Several tunnels, shafts, and pits had been made. In one of the shafts 36 feet deep the very soft decomposed peridotite extended to a depth of 32 feet. The nature of the peridotite at this outcrop is practically identical in appearance with that of the original area. Some of the less decomposed bowlders of weathering found on the outcrop contain a large number of inclusions of black slate and other materials. A thin section under the microscope showed practically the same characters as some of the sections cut from the peridotite on the Arkansas Diamond Company tract, that is, a brownish isotropic matrix with serpentinized olivine grains and small amounts of calcite throughout.

An occurrence of greenish conglomerate rock has led to prospecting for diamonds in Howard County, Ark. The deposit in question is about 4 miles north of Nashville, in sec. 2, T. 9 S., R. 27 W., on Mine Creek. An option on the land has been taken by Messrs. Williams and Cobb through Judge W. C. Rodgers, of Nashville. The conglomerate appears to be a rather recent formation cemented together by lime. It outcrops in the banks and bed of the creek. The rock is rather soft and in places the binding material has been partly leached out, so that it crumbles easily. The whole formation has a green to bluish-green color, and contains pebbles up to 2 or 3 inches in diameter of flint, jasper, chalcedony, quartz, quartzite, rhyolite or dacite porphyry, and more basic rocks somewhat altered. The matrix for the pebbles is a greenish clay containing also sand grains similar to those of the pebbles. With the aid of the microscope the presence of altered brownish chlorite, quartz, orthoclase, iron ores, and a yellowish mineral, probably epidote, were distinguished among the sand grains. The green clayey matrix has a greasy feel like soapstone when crushed, probably due to the presence of chlorite.

Under the supposition that this rock has formed in part from the wash over a peridotite outcrop, it is being tested for diamonds. Only a small amount of the rock had been washed at the time of examination and no diamonds had been found. It would be difficult to prove that this conglomerate does contain the material washed from the surface of decomposing peridotite without a more extended study of the geology of the region. It is probable that the formation is of rather late geological age and may have been laid down in the bottom along Mine Creek only

California.—Two diamonds were found during March, 1910, by a miner named George Stone in the old placer and hydraulic mine at Cherokee Flats, Butte County, Cal. These gems were picked out of a rocker with which Mr. Stone was mining for gold on the land of T. L. Vinton, of Cherokee. A large stone weighing nearly 2 carats

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[a] Econ. Geology, vol. 3, 1908, pp. 525-528.

was found first and a smaller stone weighing about half a carat was found about a week later. The nature of these diamonds was not recognized and they were only saved as attractive specimens. The larger stone was sold to T. M. James, of Cherokee, for $10, and the smaller one is reported to have been sold in Oroville. The larger diamond is a brilliant, perfectly clear, flawless stone with a slight tint of yellow. It is a crystal with much rounded and curved faces, either a trisoctohedron or hexoctohedron. The weight is said to be from 1¾ to 2 carats. The crystal is in the possession of Mr. James's mother, through whose kindness the writer was allowed the privilege of examination while at Cherokee.

The work of the United States Diamond Mining Company under the direction of M. J. Cooney has been temporarily suspended. This company owns land 1 mile north of Oroville, on which a deposit of kimberlite is said to occur, and a portion of worked-out gold placers at Cherokee Flats, 8 miles north of Oroville. Many authentic finds of diamonds in the Cherokee Flats placers are on record; there have doubtless been other finds about which little has been heard. Residents of Cherokee state that over 200 diamonds have been found which have generally been picked up by parties interested only in the gold. Some of these diamonds have come from property now owned by the United States Diamond Mining Company. As the early work was for gold alone and as no efforts were made to save diamonds that might occur with it, there may have been gems enough left in the old placers to justify prospecting for them. Some of the rock formation underlying the Cherokee Flats is very similar to that near Oroville, and the United States Diamond Mining Company is preparing to sink a shaft near the old placers.

After visiting the Oroville-Cherokee Flats region (in May, 1910), the writer is ready to hold to the view formerly expressed,[a] that rock formation in the reported diamond pipe near Oroville is practically the same as that in the contiguous country. The portion exposed by the washing off of the overlying placer deposits has been thoroughly decomposed, forming greenish-blue saprolite. In general appearance this saprolite resembles weathered peridotite or kimberlite. Weathering under the porous gravel beds has been extensive, making the complete identification of the rock more difficult. A careful examination of the less altered portions of the "blue" confirms the opinion that it has resulted from the weathering of basic rocks quite similar to those outcropping along Feather River in the vicinity of Oroville. A more complete discussion of these rock formations and their possibilities will be given in this report for 1910.

Indiana.—Occasional finds of diamonds have been made in the region north of Martinsville, in Morgan County, Ind. One of the more recent discoveries was in 1908, of a stone weighing about 1 carat, as reported by R. L. Royse, of Martinsville. Of other diamonds found in this region some are still in the possession of residents of that region. A small diamond weighing about an eighth of a carat, found in the vicinity, is held by the Bradford brothers, of Centerton, 6 miles north of Martinsville. These diamonds are recovered from the pans and sluice boxes of the gold miners, though a careful watch is not kept for them. Bronze-colored sapphire that gives a cat's-eye

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[a] Production of precious stones: Mineral Resources U. S. for 1906.

effect when cut cabochon, occasional clear sapphires of variable color, and zircon are also obtained from the placers. A clear colorless zircon from the placers, with a slight reddish stain on its surface, in the possession of the Bradford brothers, weighs 4.62 metric carats in the rough and should cut into a pretty stone.

New York.—The Jewelers' Circular Publishing Company,[a] of New York, has kindly furnished the following information on a reported diamond find in Massena, N. Y. Mrs. L. J. Barbour, now of Farmington, N. H., claims to have in her possession a stone, pronounced by jewelers to be genuine diamond, found in Massena, N. Y., about twenty years ago. It is claimed that her husband found the stone in blasting some rock from the bed of Grass River during low water, on the land of the late Abel Haskell. While the rock was being removed after blasting, Mr. Barbour noticed the crystal on a piece of rock from which he broke it. The stone was used to cut glass, for which it was found quite serviceable. Recently the crystal was examined by two jewelers who reported it to be diamond. One stated it was worth about $500 and the other that three or four good sized stones could be cut from it. This report has not been verified.

SOUTH AFRICA.

Cape Colony.—The twenty-first annual report of the De Beers Consolidated Mines [b] shows that the operations of the company were carried on in a limited way during the greater part of the year. The Kimberley, Wesselton, and Bultfontein mines were operated through the year; the De Beers mine was worked only during the month of July, 1908; and the Dutoitspan mine was closed the whole year. The total production of blue ground at all the mines was 3,557,975 loads of 16 cubic feet, as against 5,497,782 loads in 1908, and the total quantity washed was 4,774,172 loads in 1909, as against 4,965,323 loads in 1908. The stock of "blue" on the floors, not including the hard cylinder lumps, was decreased from 9,955,123 loads in 1908 to 8,738,926 loads in 1909. Though no statement is made of the number of carats of diamonds obtained in 1909, estimates made from the figures given show the output to be very close to that of 1908, which was 1,859,131 carats. The value of the diamonds sold and of stocks on hand at cost of production was £3,074,912, as compared with £3,354,524 in 1908 and with £6,452,597 in 1907. The average cost of mining and washing the diamonds was materially reduced in all the mines but the Bultfontein. The number of carats of diamonds obtained per 100 loads of "blue" washed was increased from 37 to 42.1 in the De Beers and Kimberley mines, from 27 to 34 in the Wesselton, and from 32 to 38 in the Bultfontein. That the prospects of the company are brighter is shown by the fact that the sale of diamonds during the first six months of 1909 amounted to over half of the total sales during the two preceding years.

Transvaal.—The production of diamonds in Transvaal [c] during the fiscal year amounted to 1,929,492 carats, valued at £1,295,296, a decrease of 254,998 carats in quantity and of £584,255 in value

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[a] Personal correspondence dated November 11, 17, and 21, 1910.
[b] Twenty-first Ann. Rept. De Beers Consolidated Mines for year ending June 30, 1909.
[c] Ann. Rept. Gov't Min. Eng., Transvaal, 1909.

in 1909, as compared with 1908. The production came from seven mines, sundry prospects, and the alluvial diggings at Christiana. The last contributed 1,372 carats of diamonds, valued at £4,560. The production of the Premier mine [a] during the years ending October 31, 1908 and 1909, are here given. In 1909 7,517,793 loads of earth were washed, yielding 1,872,137 carats of diamonds, valued at £1,172,378, as compared with 8,058,844 loads washed, yielding 2,078,825 carats, valued at £1,536,720, in 1908. It is reported [b] that another large diamond weighing over 191 carats has been found in the Premier mine. This diamond is described as a pure white stone, absolutely flawless, measuring about three-fourths of an inch thick, and tapering from $1\frac{1}{4}$ inches to three-fourths of an inch in breadth.

Orange River Colony.[c]—The production of diamonds in the Orange River Colony during the fiscal year ending June 30, 1909, is given by Burnett Adams as 654,319 carats, valued at £1,048,607, as compared with 505,452 carats, valued at £1,069,942, in 1908. The yield in carats per 100 loads washed was 11.33, as compared with 10.38 carats in 1908. The average price per carat fell from 42s. 1d. in 1908 to 31s. 11d. in 1909. The average price per carat for the first part of the year was only 24s. 9d., but it rose to 36s. 3d. as the market became stronger. The production came principally from the Jagersfontein, Koffyfontein, Roberts Victor, New Driekopjes, Voorspoed, and Lace mines. The output from the alluvial diggings along Vaal River was 3,017 carats, valued at £11,496, as compared with 5,447 carats, valued at £18,217, in 1908. The three largest diamonds found weighed $30\frac{3}{4}$, $30\frac{3}{8}$, and $26\frac{1}{4}$ carats, and were valued at from £200 to £170 each.

German Southwest Africa.—The discovery of diamonds [d] in German Southwest Africa was first announced on June 23, 1908, by a telegram from the governor of the Province. A little later the diamond fields were taken over by the Government. On January 6, 1909, the trade in diamonds from this colony was regulated by the establishment of the régie or monopoly. From the time this syndicate took charge of the output to October, 273,701 carats of diamonds, valued at $1,900,300 were delivered, and the production now amounts to about 45,000 carats per month.[e] These diamonds are not large, though some weighing $17\frac{1}{2}$, $10\frac{3}{4}$, 8, and $4\frac{1}{2}$ carats are reported to have been found. The average weight of the diamonds is about one-third of a carat, though stones weighing 1 carat are not rare. The stones are of fine luster and transparency, and occasionally yellow, red, green, and blue diamonds are found. It is the aim of the German Government to have the stones from the Southwest Africa Colony cut by home lapidaries. At present there are sufficient diamond cutters in Germany to handle only a small part of the output, and some stones are being cut in other countries.

Three theories have been advanced [f] to explain the origin of the diamonds of German Southwest Africa, namely, that the diamonds may be of local origin; that they may have come from former land

[a] South African Min. Jour., March 12, 1910.
[b] Jewelers' Circ. Weekly, July 20, 1910.
[c] Mines Dept. Orange River Colony, Sixth Ann. Rept., 1909.
[d] Min. Jour., London, March 3, 1910.
[e] Diedrich, Henry W., consul-general: Weekly Cons. Repts., May 28, 1910, p. 578.
[f] Marlott, R., Min. Jour., London, November 27, 1909.

now under the sea; and that they may have come from the Vaal River country.

The rocks of the diamond region are principally gneisses and granites. The diamonds may possibly be derived from such formations, but it is probable that they have come from pipes of volcanic kimberlite. So far no such rocks have been found in the diamond region.

The existence of land in Cretaceous times to the west of the present coast when the latter was submerged, has been argued as a possible source. The diamonds may have come from diamontiferous formations in this land and been washed down with the sediments forming the Cretaceous sandstones and deposited with them. By a later elevation of these sediments and by weathering processes the diamonds were liberated and accumulated during the removal of lighter and less resistant material by erosion.

The possibility of the diamonds coming from the Vaal River region from which they have been washed by Orange River is also argued. The distribution of the diamonds along the seacoast would be affected by ocean currents. Although the Vaal River diamond deposits are some 500 miles away, there are numerous waterworn pebbles of agate, etc., found with the diamonds of German Southwest Africa that resemble those found in the Vaal River region.

SOUTH AMERICA.

British Guiana.—The exports of diamonds from British Guiana [a] during the calendar year 1909 amounted to 5,646 carats, valued at $39,060, as compared with 4,968 carats, valued at $40,872, in 1908. The number of diamonds declared to the Government during the fiscal year 1909 is given by Consul Arthur J. Claire, of Georgetown,[b] as 56,982 stones, weighing 5,189 carats. The same authority quoting further from a report by the commissioner of lands and mines says that in the early days of the gold-mining industry of British Guiana diamonds were often found in the daily clean-ups. Later, in 1890, an expedition to the upper Mazaruni in search of gold found diamonds in considerable numbers though of small size. The first regular mining was done in 1900 by the British Guiana Diamond Syndicate working on a concession of 2,000 acres on Putareng Creek, a tributary of Mazaruni River. The syndicate has since gone out of existence. Still later another company, the Mazaruni Company, took up and still works a concession of 5,858 acres in the same district. Diamonds have been found on the left bank of Curibrong River, near its confluence with Potaro River. Work in this locality was abandoned, as the stones were not plentiful and were small in size, averaging about 10 or 15 to the carat.

AUSTRALIA.

New South Wales.—The production of diamonds in New South Wales[c] during 1908 amounted to 2,205 carats, valued at £1,358, a decrease of 334 carats in quantity and of £698 in value from the output of 1907. The total production since 1867 is estimated at 161,880 carats, valued at £107,503.

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[a] Min. Jour., London, January 29, 1910.
[b] U. S. Daily Cons. Repts., No. 3636, November 15, 1909.
[c] Ann. Rept. Dept. Mines, New South Wales, 1908, pp. 53-54.

DIAMOND INDUSTRY.

Increased value of the diamond.—With the revival of the trade in diamonds during 1909 an advance of 12½ per cent [a] in the wages of the members of the Diamond Cutters' Protective Union was granted by the Diamond Cutters' Association in New York. This advance places the scale of wages a little higher than they were before the panic of 1907. It is estimated that the increase would mean an advance in the cost of manufacture of about $1.50 a carat on the larger sizes and of $2 a carat on the smaller stones. A previous advance of 12½ per cent in wages was made on August 1, 1909. There are about 350 diamond workers in New York who receive wages of $35 to $75 a week. The Diamond Cutters' Protective Union is very strict about increasing the number of its members, admitting only so many as are needed to meet the requirements of the employers. From three to five years are required for a man to become a skilled diamond cutter, and with the strict requirements of the union there are not many that qualify.

An increase in the wages of the diamond cutters combined with an increase in the value of the rough diamonds sold by the London syndicate [b] will doubtless be reflected in the price of diamonds to the buyer. An increase of 3 to 4 per cent on all rough diamonds controlled by the London syndicate was made in August, 1909. Consul Henry H. Morgan, of Amsterdam,[c] reports continued increases in the price of diamonds from the De Beers mines. Increased values are due to the failure of the mines to meet the demand. During the times of depression when the output of the mines was limited the idle laborers from the diamond mines found employment in the gold mines and elsewhere. With a renewed demand for diamonds the De Beers company has not been able to secure the labor necessary to run the mines on a sufficiently large scale. The largest increase in price of diamonds has been placed on stones above three-eighths of a carat. With the smaller stones the price could not be raised so much on account of competition with the diamonds from the Premier mine and from German Southwest Africa.

Along with the announcement of the renewal for five years of the agreement[d] between the De Beers Consolidated Mines (Limited) and the diamond syndicate of London comes a report of a working agreement with the Premier mine. Reports of an agreement between the London syndicate and the German régie have appeared and been denied. It is not likely that any agreement has been reached but, the German régie will find it advantageous not to turn out too large a production of small diamonds. It is probable that a considerable number of the German Southwest Africa diamonds are turned indirectly into the hands of the London syndicate.

Sale of the Hope and other large diamonds.—During a sale at auction in Paris of a number of large diamonds, among which was the Hope blue diamond, surprisingly small sums are reported by the Manufacturing Jeweler to have been paid for the finest stones.[e]

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[a] Jewelers' Circ. Weekly, February 9, 1910.
[b] Jewelers' Circ. Weekly, September 1, 1909.
[c] Jewelers' Circ. Weekly, April 6, 1910.
[d] Jewelers' Circ. Weekly, July 20, 1910.
[e] Manufacturing Jeweler, July 8, 1909.

Metric carat.—In connection with the Cullinan diamond, attention has been called by L. J. Spencer[a] to the uncertainty that may arise through the use of the term carat to express the weight of precious stones when that weight varies in different countries. In descriptions of the Cullinan diamond no less than eight different weights, varying from 3,024 carats to 3,253¾ carats, have been used by different writers. After considering the care used in determining the weight of the diamond in the different weighings and making a study of the weights and balances used, Mr. Spencer places the weight of the Cullinan diamond at 3,025¾ English carats of 205.304 milligrams. This weight expressed in the metric system is 621.2 grams. If the metric carat of 200 milligrams becomes standard the weight of the Cullinan diamond would be 3,106.0 metric carats. The metric carat weight has been proposed by the International Committee of Weights and Measures. In France its use is compulsory by law. According to the Berlin Tageblatt,[b] the Belgian Government has also defined the carat weight to be 200 milligrams. The metric carat was adopted by Spain[c] on March 11, 1908, as the official carat.

New form of diamond cutting.—J. L. Gonard, of Brooklyn, N. Y., is reported[d] to have made an improvement in the form of diamond cutting. The table of the stone is given a concave surface, which may be obtained and a polish be imparted by a machine of simple construction. It is claimed that a much greater brilliancy is obtained in this form of cut.

EMERALD.

NORTH CAROLINA.

A new emerald locality was brought to light in North Carolina during 1909. It is on the land of W. B. Turner, 4¾ miles S. 30° W. of Shelby near the east bank of First Broad River, in Cleveland County. It is reported two emeralds were found some fifteen years ago about a mile southeast of Mr. Turner's. Little interest was shown in these emeralds locally, and no further prospecting was carried on for them. Mr. George L. English, then of New York, endeavored to find the locality from which these crystals came, but without success. Through the kindness of Mr. English, now of Shelby, N. C., the writer was informed of the recent discovery of promising crystals of emeralds on the Turner place and a trip to the locality was made in December, 1909. Up to that time some ten or a dozen crystals had been found loose on the surface of the ground. These crystals have a fine dark grass-green color. They are more or less checked, and some contain silky internal markings. The largest emerald found measures about 1 by ¾ by ½ inch. It is about half of a crystal split parallel with the length. The other stones range in size down to about a carat in weight in the rough. Some are nearly whole crystals and others are fragments of crystals. All of them are rather strongly etched and striated. One of the crystals was cut into a faceted stone of less than

[a] Spencer, L. J., Notes on the weight of the "Cullinan" diamond and on the value of the carat-weight; Mineralog. Mag., vol. 15, No. 71, March, 1910, pp. 318–326.
[b] Manufacturing Jeweler, Oct. 21, 1909.
[c] Kunz, G. F., and Stevenson, C. H., The Book of the Pearl, p. 327, Century Co., 1908.
[d] Manufacturing Jeweler, May 12, 1910.

2 carats weight and reported to have been valued by the lapidary at $20. This stone is not one of the best of those found and is rather badly flawed. The majority of the emerald crystals are checked and flawed, but there are portions in some of the crystals that would yield small clear gems of fine color. Minerals associated with the emerald crystals in the soil are colorless and smoky quartz crystals and black tourmaline.

The emeralds found loose in the soil came from an area of about 100 feet by 25 feet on a hillside of moderate slope to the northwest. The slope is toward the river on the west about 150 yards and toward a small stream entering the river at about the same distance on the north. The field in which they were found has been cultivated and the emeralds were exposed by plowing and washing by rains. Crystals of quartz and black tourmaline are found at other points on the surface near the emerald prospect. At a point about 150 yards due northeast these crystals occur rather plentifully. Between these points thin seams or shells of chalcedony were found loose in the soil. At the time of visit no development work had been done, and, as the rock outcrops are few and badly weathered, the geology was not well worked out. The locality is in a rather roughly dissected portion of the Piedmont Plateau, such as is generally found along the larger creeks and rivers. The elevation is about 680 feet above sea level, or about 30 feet higher than the First Broad River near by. The higher ridges of the Piedmont Plateau in the neighboring country are about 800 to 850 feet above sea level.

The rocks of this portion of the Piedmont Plateau are principally gneisses and schists, of great age, intruded by masses of granite and diorite. In the vicinity of the emerald prospect the types of rock are varied. There are mica, cyanite, garnet, and hornblende gneisses and schists cut by granite or quartz monzonite, gabbro, diorite, and pegmatite. The trend of the rock formations is to the northeast and and east of north near the prospect, and west of north a mile farther in that direction. The dip is generally to the southeast.

Hornblendic rocks are prominent in the gneisses and schists on each side of the emerald deposit for a distance of a mile or more. These hornblende rocks are in part, at least, metamorphosed phases of the gabbro masses occurring in the region. The gabbro outcrops form large rounded spheroidal bowlders of weathering where the rock has not broken down to soil. The granite forms a few ledges of grayish semidecomposed rock in rather light sandy soil. The gabbro and hornblendic rocks form dark reddish-brown clay soils. The emerald prospect is in a small area of basic rock with granite or monzonite outcrops on either side. Specimens gathered from the surface of the ground consist of gabbro, hornblendite or amphibolite after pyroxenite, chloritized amphibolite, and pegmatite. About 20 yards west of the emerald prospect is an outcrop of biotite granite or quartz monzonite. The width of the gabbro belt is over 100 yards, and the rock on the east side is granite or quartz monzonite.

The gabbro outcrops in a few large nigger-bead bowlders with a grayish-black color and medium grain. Under the microscope the constituent minerals are found to be red-brown hornblende, colorless augite, olivine, bytownite feldspar, biotite, and pyrrhotite. The olivine grains have around them reaction or alteration rims, probably composed of actinolite. The biotite has a strong yellow to reddish-brown pleochroism. The amphibolite was found only in small blocks on the surface and has a greenish-yellow or brown color. The constituent minerals are chiefly pale-brown hornblende, with small amounts of augite and iron ores. The hornblende appears to be formed from pyroxene. The chloritized amphibolite has a greenish color and grades into chlorite schist or "soapstone." It is composed of chlorite, green hornblende, actinolite, biotite, iron ores, and small amounts of plagioclase feldspar. The quartz monzonite rock on the west of the prospect is a speckled gray rock of medium grain, composed of quartz, feldspar, and mica, and the field name would be biotite granite. The microscope shows the component minerals to be quartz, andesine feldspar, biotite, muscovite, and a little zircon. The rock should therefore be classed as quartz monzonite.

The gradations from very basic rocks to more acid types in a small area suggest either a basic segregation in the original igneous magma or an inclusion of a basic rock mass in a more acid or granite magma, with an absorption by the latter of part of the former. Results of the latter process are in evidence at numerous localities in the Piedmont Plateau, and the formations of the emerald locality seem to adapt themselves well to this theory. An original mass of gabbro, probably with more basic phases as pyroxenite, was inclosed in a large intrusion of granite magma. The gabbro was broken and blocks of it were floated off and partly or completely absorbed by the granite magma. The latter became more basic near the gabbro mass and graded into it. Thus rocks ranging from ordinary granite to monzonite, diorite, and gabbro would be formed around the original gabbro. This series may be seen more plainly at other places in the neighborhood. Through the fractures and fissures pegmatitic magmas or solutions passed from the cooling granite into the adjacent rocks, forming pegmatite dikes and veins such as that in which the emeralds have been found.

In April, 1910, and more recently some prospecting was done at the emerald locality. Mr. English has kindly furnished notes on the results of this work for the following description and loaned a representative collection of wall rock, vein matter, and emeralds for examination. Developments consist of a pit 6 feet deep, a trench 14 feet long started in the hillside to drain the pit, and another trench 25 feet long at a distance of 15 feet northwest of the pit. A pegmatite vein or lens was found, which has a thickness of 30 inches at the surface on the east side of the pit and 18 inches on the west side. In the bottom of the pit the vein has a thickness of about 18 inches on each side. The 25-foot trench was cut to a depth of 3 feet and did not encounter any pegmatite. The vein strikes about N. 70° W. with a dip of 75° N.

The pegmatite is composed of quartz and feldspar, part of which, at least, is albite, with some black tourmaline sprinkled through it and an occasional emerald or green beryl crystal. The texture of the pegmatite varies from medium-grained to fairly coarse, with nearly pure feldspar and quartz masses 18 inches through. The crystallization is not especially good, though some fairly well developed crystals are found in small rude miarolitic cavities. Crystals found in the cavities are colorless and smoky quartz, albite feldspar, with sometimes black tourmaline and green beryl. The cavities in the pegmatite are partly filled with reddish-brown, greasy-feeling clay, and the same material, along with limonite stains, has permeated joints and seams through the pegmatite. The feldspar of the pegmatite has partly decomposed in places, so that the rock breaks down rather easily. The emerald crystals found in the vein are smaller than most of those found on the surface and have a much paler color. A considerable number of these beryl crystals were found, ranging from pale emerald green to a fairly dark green. Mr. English washed three washtubfuls of partly decomposed vein material and obtained 34 small crystals and fragments of emerald. There were no emeralds visible in this material before washing. The crystallization of the quartz and feldspar so far found in the pegmatite vein is not so perfect as that in the veins once worked for beryl and hiddenite at Hiddenite, N. C. The albite assumes the form of rough crystals and of aggregations of stout crystals, though not of the cleveland ite type common in many gem-bearing pegmatites. The quartz occurs in crystals of average perfection and in many of the specimens exhibits trapezohedral faces indicating a right-hand character. Some of the quartz is nearly colorless and other is smoky colored. One crystal of quartz examined is penetrated by numerous fine light-colored needles, probably actinolite. The emerald crystals are simple hexagonal crystals of beryl with the prism faces and base. Many of them are deeply striated and etched, especially on the prism faces. Other crystals have internal striations or irregularly shaped tubes extending through their length. In some cases these tubes are of considerable size compared with the crystal inclosing them and have been filled with clay or iron stains. The finer tubes appear as silky striations in the crystals. A pretty specimen of emerald in the matrix found in the vein consists of light emerald-green beryl crystal 17 millimeters long and 3 millimeters in diameter embedded in quartz and albite. The emerald is partly embedded in each mineral. The quartz has a light smoky color and is roughly crystallized. The albite also shows rude crystallization and, along with the quartz, is slightly stained with iron. The emerald is transparent, though somewhat checked by flaws. Some of the faces of the prism zone are much striated.

Among the specimens loaned by Mr. English were 16 cut gems. One of these was a faceted table cut stone of 77 milligrams or 0.385 metric carat weight and might be worth from $5 to $10. The stone had a flaw in the middle and was light emerald green. The rest of the stones were cut cabochon and drop shape and were nearly all dark colored, some of a fine emerald green. All contained checks and flaws or silky striations. The dark-colored stones of this grade might be valued at from $20 to $25 per carat. Three drop-shaped emeralds weighed 326, 267, and 251 milligrams, or 1.63, 1.33, and 1.26 metric carats, respectively. These three stones were sufficiently well matched to be used as pendants in a necklace and, though more or less flawed, had a good color. They should be worth at least $25 a carat. Other gems cut cabochon were of better quality, though slightly paler in color than the three drop-shaped stones. Several of the emeralds cut cabochon exhibit a fairly good cat's-eye effect along the silky internal striations, very similar to the effect and due to the same cause of the tourmaline cat's-eyes from southern California. The crystal from which the faceted gem was cut was obtained from the pegmatite vein. The other stones with deeper color were cut chiefly from crystals found on or near the surface.

As the prospect pit has been made on the hillside below the point at which some of the emeralds were found and has yielded only gems with a paler color than those found on the surface, it is possible that there is another vein.

Mr. Thomas English, of Sprucepine, N. C., reports the discovery of a new emerald prospect near the Emerald Matrix mine, on Crabtree Mountain, 4 miles southwest of Sprucepine, in Mitchell County. The new prospect is about a quarter of a mile north of the old mine and considerably lower down on the side of Crabtree Mountain. Only a few blasts had been put in, and several specimens had been obtained. These crystals are said to have a little paler color than those of the old mine. Some of the emeralds are of pencil thickness, though most of them are somewhat checked. The best emerald matrix material is said to be the dark-colored quartz wrapped in scaly biotite.

FELDSPAR GEMS, AMAZON STONE.

COLORADO.

Some good amazon stone was mined by J. D. Endicott, of Canon City, Colo., at his claim 4 miles north of Florissant. Part of the product was cut and part was disposed of in the rough. The better grades of amazon gems from this locality are very good.

GARNET.

ARIZONA.

The geographical location of the "Arizona ruby" or garnet field, described in this report for 1908, has been obtained a little more accurately by the work of H. E. Gregory in the search for water for the Navajo Indians. The locality is not on the northwest side of Gypsum Valley, in Utah, but in Arizona on the southeast of Gypsum Valley, about 4 miles south of the locality given by the writer in this report for 1908. When the locality was visited it was without the aid of a detailed map and with an Indian guide who could not speak English. The lack of water and supplies and the limited time for so long a trip made it difficult to secure the proper data of location.

IDAHO.

Garnets suitable for cutting into small gems are occasionally picked out of the gold placers in various parts of Boise County, Idaho. In the Deadwood Gulch placers dark-red garnets as large as pecan nuts have been found. Some of these are sufficiently clear and light-colored for cutting into faceted gems, while others are so dark as to be suitable for carbuncle cuts only. Specimens examined were partly water-worn fragments of crystals with a few of the crystal faces still present. Miners report these garnets to be rather plentiful.

CALIFORNIA.

Fine specimens of hyacinth-colored garnets are reported from the Hercules mine, near Ramona, by Mr. A. W. Pray. The best specimens consist of the garnet associated with albite feldspar. About 50 pounds of this material was mined.

PENNSYLVANIA.

Specimens of rough garnet in mica schist and gems reported to have been cut from them were kindly loaned by Mr. Frank C. Reighter, of Chicago. Mr. Reighter obtained these from a locality in eastern Pennsylvania. Some of the cut gems have the fine violet red color of almandine.

IOLITE, CORDIERITE.

CONNECTICUT.

Prof. S. Ward Loper, of Wesleyan University, reports the collection of 75 good specimens of iolite or cordierite at Guilford, Conn. Some of this material has crystal forms. The collection has been placed in the museum of Wesleyan University.

JADE.

BURMA.

The exports of jade (jadeite) from Burma through Rangoon in 1908 amounted to 3,211 hundredweight,[a] valued at £73,400, as compared with 2,636 hundredweight, valued at £49,643, in 1907.

NATROLITE.

NEW JERSEY.

Mr. Frederick A. Canfield, of Dover, N. J., reports the finding of about 30 pounds of large crystals of light-brown natrolite at Paterson, N. J. Some of these crystals were to be cut for gem purposes.

CALIFORNIA.

The occurrence of natrolite with benitoite in California has been described under benitoite. None of the California natrolite has been used for gem purposes, though the pure white masses of globular and mammillary natrolite with drusy surfaces associated with benitoite and neptunite make splendid cabinet specimens.

OBSIDIAN.

OREGON.

Specimens of leek-green obsidian, exhibited at the Seattle Exposition, are mentioned by Dr. O. C. Farrington, as possible gem stones. The material is clear, though rather badly fractured, and would yield small gems only. It is reported to have come from Mount Hood.

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[a] Rec. Geol. Survey India, vol. 38, pt. 1, 1909.

OPAL.

NEVADA.

Prof. J. C. Merriam, of Berkeley, Cal., has kindly furnished further information on the occurrence of the opal in Humboldt County, Nev., mentioned in this report for 1908. According to Professor Merriam, the opal occurs in the Virgin Valley formation, as described by him.[a] This formation is of Tertiary age and in places carries good opals in veins or cracks in fossil-bearing beds.

Specimens of opal from this region, furnished by Mr. H. E. Rinehart, of Denio, Oreg., exhibit a splendid fire and display of color, though none of large size was seen. Some of the specimens are opalized wood, in which nearly all of the woody texture has been lost. Such specimens as were seen are petrifactions of small limbs of trees and consist of opal of fine quality.

Mr. R. C. Hills, of Denver, Colo., refers an opal deposit tested by himself in the Virgin Valley region to the John Day Miocene formation. At this deposit tusks and teeth of a mastodon were found during the digging for opals. Considerable opalized wood and some white opal occur in the vicinity, but little good gem material is found. Black and green gem opals were found in a space about 2 rods square. The gem material was rather badly checked and flawed, and few fine gems were found. Probably not over $200 worth were taken out during 1909.

AUSTRALIA.

New South Wales.—The value of precious opal produced in New South Wales [b] in 1908 amounted to £41,800, as compared with £79,000 in 1907. The White Cliffs division of the opal region furnished £31,800 and the remainder came from the Walgett division. The latter production consisted chiefly of high-grade dark opal, known as "black opal" in the trade. The large decrease in the value of the production of opal is not so much due to the falling off of the quantity or quality of the gem produced as to a decline in the market price, especially in the United States, where the gem has hitherto found its readiest sale.

During 1909 opal mining was carried on actively in the White Cliffs and the Lightning Ridge or Walgett regions. Much fine gem material is reported [c] to have been found, for some of which £5 to £10 per ounce was paid, and £30 per ounce for other parcels.

Queensland.—The production of opal in Queensland [d] in 1908 was estimated at £2,500, as compared with £3,000 in 1907. The production was obtained largely by picking over old workings and dumps, and much of it consisted of small chips and poorer grade material. The scarcity of water in the opal field makes prospecting and mining very difficult. The industry might be stimulated by sinking wells or placing tanks at selected places.

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[a] Science, new ser., vol. 26, p. 380.
[b] Ann. Rept. Dept. Mines, New South Wales, 1908, p. 54.
[c] Min. Jour., London, Anniversary Number, August, 1909; also August 21 and September 18, 1909.
[d] Ann. Rept. Under Secretary of Mines, Queensland, 1908.

CANADA.

Fire opal is reported to have been found in British Columbia,[a] near Kamloop, in the bed and banks of Deadman's Creek. The gems are said to be similar to the Mexican fire opal.

PECTOLITE.

NEW JERSEY.

Mr. Frederick A. Canfield, of Dover, N. J., reports the finding of a few pounds of greenish-white pectolite at Paterson, N. J. This material is translucent, and some of it has been cut for gem purposes. Massive white pectolite was also found in the new Erie Railroad cut through Bergen Hill, N. J.

PERIDOT.

ARIZONA.

Peridot of gem quality has been found in two regions in Arizona. One of these is in the Navajo Indian Reservation, as described in this report for 1908. The other region is in the San Carlos or White Mountain Apache Indian Reservation, near Rice, or the old Talklai post-office, and 6 miles distant from Mesa. The production of peridot from these regions has declined during the last few years, so that there is but little annual production, and that reported comes in part from material collected several years ago. The decreased production is due to several causes, among which are overproduction, with a flooding of the market soon after the discovery; the occurrence of the deposits on Indian lands, so that they are only partly available to white people; lack of interest on the part of the Indians who once collected the gems; and the low prices offered by dealers. The demand for large peridot with good color remains, though there are stocks of the smaller-sized gems on hand for which there is not a good market. The material produced at present consists mostly of small sizes, since the more readily available peridots that would cut large gems have been carefully gathered up. It is probable that large gems of good color can still be obtained in either region mentioned, though labor and systematic work would be necessary. The greater part of the production has been through the Indians, who gather the loose peridot pebbles from the soil and wash formed by the disintegration of the rock matrix. Near Rice some gems of fine quality have been obtained, principally by white men, by blasting and breaking up the basaltic rock in which the gems occur. Large loose blocks and cliffs of the basalt have been blasted and the peridot worked out by hammer and chisel.

The post-office of Rice is in the Rice Indian school, and the station is on the Gila Valley, Globe, and Northern Railroad, about three-fourths of a mile to the south. The railroad approaches Rice from the southeast up San Carlos Creek and swings to the west near the station up a tributary of the creek. The school is in the main valley of San Carlos Creek. The valleys near Rice are from one-fourth of a

[a] Manufacturing Jeweler, February 17, 1910.

mile to over a mile wide and contain lands sufficiently level for irrigation and farming. In other parts there are numerous hills and terraces of gravel. The valleys have been cut through mesas and table-lands formed principally by basalt flows at different elevations. The first basalt-covered mesa is about 200 feet above the creeks and extends, rising with a gentle slope, from one-half mile to 3 miles back from them, where it is succeeded by higher plateaus or hills. This mesa is covered with the scoriaceous surface of a basalt flow, which forms malpais land on each side of the creek and between the forks. The elevation of Rice is 2,635 feet above sea level.

The peridot gems have been found principally in and along Peridot Canyon, which enters the railroad valley about one-fourth of a mile west of the station. Peridot Canyon drains to the northeast and is about $1\frac{1}{3}$ miles long. It cuts back into a large area of malpais country on the first mesa south of the railroad, with a depth of about 25 feet at its head and 200 feet at the mouth. The canyon heads off with a small cliff, above which there is an arroyo leading back on the table-land. Peridot Canyon ranges in width from 50 yards at the upper end to 200 yards at the lower end between the cliffs forming its upper walls.

The most prominent rock of the region is the basalt, which forms the malpais-covered mesas. This basalt ranges from 25 to probably over 100 feet thick. At only a few places in the canyons do the underlying rocks outcrop. In the lower end of Peridot Canyon white to gray cross-bedded sandstone and tufaceous conglomerate outcrop under the basalt flow. These rocks are horizontal or only gently folded and are baked along the contact with the basalt. In many places the rocks underlying the basalt in the canyon or valley walls are concealed by a heavy talus of the basalt. The latter rock exhibits little or no sign of columnar jointing, but in places possesses a nearly horizontal sheetlike structure or bedding. It is vesicular to a marked degree in the upper part of the beds and less so in the lower part. The basalt is a normal grayish-black olivine basalt, in which there are inclusions of olivine or peridot of considerable size. In thin sections under the microscope the component minerals are seen to be labradorite, in small lath-shaped crystals; augite, with a brownish-violet color in small grains, laths, and aggregations of grains; olivine, in grains, crystals, and larger masses (peridot); and iron ore in numerous minute and occasional large grains and crystals. Many of the olivine grains are surrounded by a film of hematite stain. The texture of the basalt is medium grain for that rock, though the constituent minerals can not be distinguished without the use of a microscope. Besides inclusions of balls of peridot or olivine the basalt contains occasional small masses of black glass.

The peridot occurs in rounded, oval, semiangular, and angular-shaped balls and masses in the basalt. These inclusions range from a fraction of an inch to 8 or 10 inches in diameter and are very irregularly distributed through the rock. In some places they occur within an inch or two of one another through a large volume of basalt, and at others they are almost absent or separated by several feet of barren rock. These masses consist of granular olivine or peridot and diopside. They range in texture from grains as fine as those of ordinary sandstone to grains measuring an inch or more in diameter. These grains are rounded to subangular and angular and consist of individual crystals of olivine and diopside, which were prohibited from assuming crystal form by crowding. These inclusions are practically the same as small masses of peridotite and may represent fragments of that rock torn from masses underground, through which the basalt lava was forced. It is possible, also, that these inclusions of peridotite represent very basic segregations in the basalt lava, though their irregular distribution and abundance in certain places and their absence in other places do not indicate such an origin. The balls are composed principally of peridot. The diopside is less prominent and occurs in two shades of color, dark bottle green and emerald green. The diopside reacts for chromium and is chrome diopside. Few specimens, if any, of the diopside are obtained that are large enough to cut as gems. Among interesting specimens collected from the gravels of Peridot Canyon is a white to colorless crystal of albite, measuring roughly 1 inch square and three-fourths of an inch thick; the surface is somewhat etched.

In a large number of the peridotite inclusions in the basalt there are no olivine grains sufficiently large to cut as gems. In some portions of the basalt the peridotite inclusions, no matter how numerous, are all too fine-grained to be of value. In other places a good portion of these inclusions may contain gem material and several large clear gems along with smaller ones may be secured from a ball of 2 or 3 inches in diameter. Apparently good gem peridot was found in the largest quantity in the upper part and near the head of Peridot Canyon, for this is the place where the greatest amount of work has been done. In places there are joints and seams cutting the basalt, along which there has been more or less weathering. The rock along these seams can be easily worked, and good gem material is sometimes secured. In other places the fresh hard basalt is blasted and broken up in search of gems. As a general rule the peridotite masses crumble readily as the inclosing basalt is broken away, so that the gems are easily picked out without more fracturing than that caused by blasting. Occasionally nearly solid crystals of gem peridot of the size of an English walnut are inclosed in basalt with little or no granular olivine around them. It is almost impossible to free such crystals from their matrix without fracturing badly. In breaking up the basalt and the included peridotite rough gems ranging from small size to as large as a pecan nut were obtained. The principal yield is in pieces that when cut up would weigh between 1 and 3 carats. Larger stones are not uncommon.

The rough peridot broken from the fresh rock is brilliant and clear. That obtained along seams is apt to be etched or stained on the surface, though clear and of good color within. Pebbles gathered from the canyon gravels or over the mesa country also have dull and more or less stained surfaces.

It is said large quantities of peridot, liberated by the disintegration of the inclosing rock, have been gathered by the Indians from over the mesa country and from the gravels of Peridot Canyon. If such is the case, the loose gems must have been gathered up with great care, for few of them are now left on the mesas. A few peridots sufficiently large to cut may still be found in the gravels of Peridot Canyon and in places the olivine sand is gathered into hills by the ants as described in the Navajo region. The earlier supply of peridot from this region placed on the market consisted of crystals or masses with dull surfaces, such as is still found loose in the soils and gravels. Since the best gem material now has to be broken from the rock it may be recognized by the bright surfaces of the fresh fractures. Unless a new locality where loose peridots can be gathered from the surface is found, the supply from this region will have to be obtained by blasting the basalt and carefully chiseling out the gems.

Gem peridots have also been found in the adjoining canyons southeast and northwest of Peridot Canyon, and in the basalt-capped mesa a few hundred yards north of the Indian school. They are not plentiful in these places, and the number of peridotite inclusions in the basalt is very small. Peridotite inclusions in basalt were found a little over $1\frac{1}{2}$ miles west of Rice, along the railroad. A few of these seemed to give promise of the occurrence of gems at that locality. Another reported locality is over a mile southeast of the Indian school, across the San Carlos Creek.

The best gem peridots from the Rice locality are of about the same color and quality as those from the Navajo Reservation. It is probable the yield of good gem material from equal amounts of rough, unselected peridots is much larger in the Apache fields than in the Navajo fields. Peridots from the latter region contain a larger proportion of brownish-green stones than those from the Rice locality. The brown color of the Navajo peridot is caused by numerous microscopic brownish inclusions of six-sided plates of mineral, while in the Apache stones the brownish-green is apparently due to the natural color of the stone. Inclusions of small black specks and cavities or flaws occur in the Apache peridots in sufficient quantity to ruin them as gems in some cases. The beautiful light-yellowish green and richer green colors so much admired in peridot are present in many of the gems.

PHENACITE.

COLORADO.

In operating the aquamarine deposits on Mount Antero, Colo., Mr. J. D. Endicott, of Canon City, has obtained some phenacite crystals suitable for gem and specimen purposes.

QUARTZ.

OKLAHOMA.

Mr. Oliver Powers, of Lawton, Okla., has furnished the following note on quartz from the Wichita Mountains, Okla.: Some years ago there was considerable interest in "Wichita diamonds" and several people in the region sent specimens away for cutting. A number of the cut stones were very clear and of good luster, and part may have been topaz which is reported to have been found in this region. When it was found that the crystals were not diamonds the interest in them subsided. A more interesting variety of the quartz is that inclosing fine needles of silvery white and golden colors. The latter may be rutilated quartz. This hairstone has been cut and used locally for jewelry.

COLORADO.

Mr. W. C. Hart, of Manitou Springs, Colo., reports a production of about 1,000 pounds of smoky quartz from the west side of Pikes Peak, Colo. The smoky quartz occurs in crystals up to 10 and 15 pounds in weight. The exterior of the crystals is coated with a layer of cloudy to opaque quartz. The interior is composed of dark smoky brown clear quartz of fine cutting quality. Mr. Hart has on exhibition faceted gems cut from this quartz that measure nearly 2 inches across.

ROSE QUARTZ.

NEW YORK.

An asteriated variety of rose quartz has been described by James G. Manchester.[a] The description is illustrated by a photograph which shows a six-ray star very plainly in a sphere 18 millimeters in diameter cut from the rose quartz. This rose quartz has a delicate rose tint and is quite translucent. The star is seen only in spheres of the rose quartz by transmitted light. This asteriated rose quartz is found at the Kinkle and the Hobby quarries in the towns of Bedford and North Castle, respectively. These quarries have been described by Edson S. Bastin.[b] Mr. Manchester states that a sphere cut from rose quartz from Maine does not show the asteria effect, while that from California and Brazil exhibit it only by reflected light. No satisfactory explanation has been offered as to the cause of asterism in rose quartz.

TOURMALINATED QUARTZ.

NEVADA.

Mr. R. C. Hills, of Denver, Colo., reports the occurrence of fine tourmaline needles in glassy quartz near the hübnerite tungsten deposits at Osceola, Nev. This material comes from a new locality discovered by George Doyle, of Osceola.

RHODONITE.

CALIFORNIA.

A deposit of beautiful rhodonite for gem purposes has been located in the Happy Camp mining district, Siskiyou County, Cal. This deposit is about 6 miles east of the californite locality and high up in the mountains. It is owned by Cyrus Wheeler, of Los Angeles, and the output of the gem has been handled by the Southwest Turquoise Company of the same city. This rhodonite has the most delicate tints of pale to dark rose-pink. Much of it is marked by seams of black manganese oxide, which form a beautiful contrast with the rhodonite. A description of the locality will be given in this report for 1910.

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[a] Asteriated rose quartz in New York: Min. World, June 11, 1910, pp. 1185–1186.

[b] Contributions to economic geology, 1906: Bull. U. S. Geol. Survey No. 315, pt. 1, 1907, pp. 394–399, and feldspar deposits of the United States: Bull. U. S. Geol. Survey No. 420, 1910, pp. 60–63.

NEW JERSEY.

Prof. John E. Wolff, of Harvard University, and Mr. Wallace Goold Levison, of New York, report some semitransparent rhodonites of very beautiful pink color from the Franklin Furnace region, New Jersey. These crystals came from the Parker shaft. Mr. Frederick A. Canfield, of Dover, N. J., states that a small quantity of fowlerite or zinc rhodonite, from this region, found in 1909, was suitable for cutting into small gems. These had a rich red color. Some larger crystals with superior color were also found.

RUBY.

BURMA.

According to E. A. Wakefield,[a] of Rangoon, there are four principal ruby mines in the Mogok Valley, Burma, with smaller workings in the adjacent valleys. In the four larger mines modern machinery and methods are used in mining and washing for rubies; the smaller mines are operated by the natives with hand labor. The results obtained by the latter are sometimes surprisingly good. In the larger mines the overburden or "byon" is first removed to the ruby-bearing clay. The clay is dug up and carried by trolleys to steam cleansing mills, where it is washed through sieves and examined for ruby and spinels. It is not often difficult for the expert to distinguish between the real ruby and the balas ruby or spinel. The mining interests are very liberal with the natives and provide good quarters for their employees. The town of Mogok is located on rich gem-bearing ground and is being removed as operations progress. As the quarters for the natives are removed comfortable new ones are supplied.

SAPPHIRE.

QUEENSLAND.

The production of sapphire for gem and mechanical purposes in Queensland [b] during 1908 is estimated at £15,200, as compared with £40,500 in 1907. The production of gem sapphire was £11,800. The large decrease was doubtless caused by overstocking the market during a period of dull trade, especially in Russia, where the Queensland sapphires are much used. During 1909 sapphires estimated as valued at £17,320 are thought to have been sold locally by the miners.[c] The Queensland sapphires do not bring so high a price as many of the sapphires from other countries, being considered of inferior grade. Many of these sapphires are cut in Germany, though a few are cut locally.

CEYLON.

Mr. Edward A. Sweet, 12 Spencer Court, Brooklyn, N. Y., obtained one of the largest known sapphire crystals from Ceylon during 1909. The crystal weighs 10 pound 6 ounces troy, and is approximately 7½ inches long by 3½ to 4 inches thick. It has been slightly water worn and has a grayish color. The crystal was obtained for cutting up for mechanical use, but it is hoped that it may be saved for some collection.

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[a] Daily Cons. Repts., July 26, 1909, No. 3541.
[b] Ann. Rept. Under Secretary of Mines, Queensland, 1908.
[c] Australian Min. Standard, February 9, 1910.

TOURMALINE.

MAINE.

During the year 1910 a new deposit of tourmaline was opened on the land of F. L. Havey, near Poland, Me. The deposit is on land adjoining the Berry property, where feldspar and tourmaline have been mined. Mr. George R. Howe, of Norway, Me., with the permission of Mr. Havey, has kindly furnished notes on the tourmaline taken from the mine during the time of operation from July to October, 1910. The features of these tourmalines are the predominance of green and the fine quality and clearness of the gem material. Some fine rich blue (locally called "Alice blue") tourmaline is also obtained. Rubellite and achroite terminations are present on both the green and the blue crystals. Yellowish-green and yellow colors also occur. Some crystals (locally called "watermelon" crystals) have pink centers and green margins. Of a representative collection containing 108 crystals, chosen from the output of the mine, 98 crystals are of gem quality and weigh 3,231 carats. It is estimated that this should yield 1,000 carats of cut gems.

CALIFORNIA.

The trade with Chinese merchants in pink tourmaline from California has grown to a considerable industry. According to Mr. Harry E. Dougherty, of Hemet, Cal., the Chinese market called for all grades and sizes in the early stages of the trade, but the demand is now only for larger crystals and medium dark pink gems. Pale colors and reddish-pink gems are not wanted. The checked and flawed tourmaline, such as is cut "en cabochon," is desired and not the high-priced flawless gems. The greatest demand is for pieces from an inch and a half in thickness to the largest sizes obtainable. The tourmaline is supposed to be used in beads and other jewelry, and in the case of larger crystals a core is taken out and the shell is polished and used as a tube to dress the hair with. Prices up to $150 per pound avoirdupois are paid for suitable material. Mr. Dougherty estimates the value of the purchases by the Chinese during 1909 to be close to $100,000.

A large sale of tourmaline by L. Tannenbaum, of the Himalaya Mining Company,[a] of New York, to a Chinese merchant is reported to have been made during the summer of 1910. This consisted of 358,500 carats of pink tourmaline crystals ranging in size from 100 to 1,000 carats.

TURQUOISE.

DEPOSITS AND MINING.

Turquoise deposits have been tested or worked in the following States: Arizona, California, Colorado, Nevada, New Mexico, and Texas. The largest production has come from the mines of New Mexico, Arizona, California, and Nevada. The quality of the gem material from the different States and from the different mines in the same State varies greatly. The finest gem material has probably

[a] Jewelers' Circ. Weekly, August 3, 1910.

come from some of the mines of New Mexico and Nevada. The turquoise mines of New Mexico were the first to receive attention, and the output from this Territory has exceeded in value that of any State. A large number of the turquoise deposits so far found in the Southwest were worked by the ancient Aztecs, and a few by the Aztecs under Spanish rule. Many of the deposits have been located by opening these old mines or prospecting around them..

The turquoise deposits of the different States have many points of resemblance. The occurrence is nearly always in arid, if not desert, regions of considerable elevation. The operation of the deposits is therefore often attended by hardships, due to excessive temperatures with extreme temperature changes, high winds, lack of water, and difficulty of securing wholesome food. The prospector is beset with the same or greater difficulties, since his equipment is often limited, and therefore the location of new deposits requires patience and endurance. The occurrence of turquoise is generally in or near such igneous or volcanic rocks as granite, quartz or monzonite porphyry, and rhyolite or trachyte. These rocks are generally more or less altered, and it seems to be due to this alteration that it has been possible for the turquoise to form. The common form of alteration near the turquoise deposits is sericitization or kaolinization, either or both. Some of the turquoise mines are in regions where large copper mines have been discovered. Copper prospects have been found near other deposits, and generally indications of copper near turquoise deposits are readily seen.

To appreciate the difficulties encountered in locating and operating turquoise mines, one must see the prospector or miner in the desert regions. A few of the mines are fairly well provided with water and transportation facilities, so that comforts may be obtained.

At many mines the water supply for the camp for all purposes must be hauled in barrels from 1 to 15 miles, and at some mines it has been necessary to haul water 30 miles or more. The difficulties of mining account for the large number of partly prospected deposits lying idle in many parts of the Southwest. Mines known to contain good turquoise in quantity are not worked because they are in regions too difficult of access.

ARIZONA.

The principal turquoise mining region of Arizona is near Mineral Park, in Mohave County. The mines at this locality were described in this report for 1908. Of the several companies operating at that time all continued work during part, at least, of 1909. Turquoise has been mined in the Gleason district, in Cochise County. Turquoise of fair quality is reported to have been obtained from some of the mines of this district when operated a few years ago.

CALIFORNIA.

The principal turquoise mines of California are in the northeastern part of San Bernardino County, nearly 100 miles north of the Needles.[a] These deposits were operated by the Aztecs, and many signs and inscriptions of these people have been found on the rock.

[a] Kunz, G. F., Gems, jewelers' materials, and ornamental stones of California: Bull. California State Min. Bureau No. 37, 1905, pp. 107–110 and 152–153.

The principal operators in this region in recent times have been the Himalaya Mining Company and the Toltec Gem Mining Company. The properties of these companies are about 6 miles apart and have not been operated for several years.

More recent mining for turquoise has been carried on farther south in San Bernardino County, near Cottonwood siding on the Santa Fe Railroad.

Gove turquoise mine.—The Gove turquoise mine is in the Mohave desert, about 2 miles west of Cottonwood siding, on the Santa Fe Railroad, in San Bernardino County. It was operated during 1908 by C. A. Gove, of the California Gem Company, of Los Angeles. The mine is in a low ridge which slopes gently down to the sand flats along Mohave River on the east and northeast. The deposit has been opened by two shafts, about 20 and 30 feet deep, respectively, with a little drifting, some crosscut trenches, and several small pits. These workings are all within a distance of 150 yards in a northeast-southwest direction.

The country rock is principally a fine-grained, dark-gray biotite gneiss or graywacke, which strikes N. 30° E. with a nearly vertical westerly dip. In thin section under the microscope the constituent minerals are found to be biotite, with a yellowish to brownish green pleochroism, and quartz. The biotite occurs in laths and plates with a rough parallel orientation. The quartz grains are small and rounded to angular. The graywacke is cut by a belt of schistose rhyolite or fine porphyry, about 100 yards wide. This porphyry has been squeezed and partly altered to a sericite schist. The constituent minerals determined in thin section are muscovite or sericite, quartz, and orthoclase. The texture of the original rock was very fine grained, and portions of this texture are preserved, though with a schistose structure. There has been a partial decomposition and kaolinization, with a consequent liberation of free silica, which has been deposited in seams and fractures through the rock.

The turquoise occurs along the contact of the graywacke and the rhyolite. This contact is rather irregular, and the turquoise has been deposited in both formations. Seams of limonite fill numerous joints and fractures in each rock, and stains of iron oxide have worked along the schistosity of each. Turquoise occurs in seams and nuggets in each rock and is generally associated with the limonite in the graywacke. In the rhyolite the turquoise is sometimes found with quartz or with stains of limonite. The nuggets of turquoise have developed along limonite seams, in fracture zones, and apparently in hard rock also; they range from a fraction of an inch to over an inch in thickness, and most of them are elongated in the direction of the schistosity of the rock. The nuggets are fairly plentiful in a few places in the shafts and the tunnels. The seams of turquoise cut the rock in various directions and are not often large enough to yield gem material. Many of the nuggets are pale and rather too soft for cutting; some of them, however, have a good blue color and the usual hardness. The turquoise from the graywacke is in general of much better grade than that from the rhyolite. The best turquoise from the Gove mine has a rather light to medium dark, pure blue color. The lighter blue may be called "baby blue." The principal value of the production is in the pure blue turquoise, though the yield is not large.

In a copper prospect opened 150 yards northwest of the turquoise mine a 6-inch vein of dark-gray quartz with stains and seams of blue chryscolla and green malachite has been found. This material might serve for cutting into cheap copper-ore gems. About a mile southwest of this prospect similar material was found associated with pyrrhotite and chalcopyrite.

COLORADO.

The mine of the Colorado Turquoise Mining Company, 13 miles S. 60° E. of La Jara, Comejos County, has been leased by C. G. King, of Manassa, Colo., and C. H. Wyman and H. E. James, of Colorado Springs, who set up a polishing plant at Colorado Springs and cut turquoise during the last part of 1909 and were operating during the first part of 1910. The mine was described in this report for 1908. Handsome matrix is obtained with dark to light-blue and greenish-blue turquoise, mottled with brown iron stains and seams of limonite.

NEVADA.

The turquoise mines in Nevada have been exploited more recently than in the other States mentioned. There are two principal regions, the Esmeralda-Nye County region and the Searchlight district in Lincoln County. The mines of the Esmeralda-Nye County region have been the most productive, and some of them are in operation at present. Turquoise has been found at numerous points within 25 miles of the Goldfield Railroad, between Sodaville and Goldfield, in both Esmeralda and Nye counties. Other deposits have been found to the north, near Yerington, in Lyon County. Some of the deposits are more or less closely associated with variscite, which mineral has been mistaken for turquoise by some of the prospectors. The quality of some of the turquoise from this part of Nevada is especially fine in both color and hardness.

Royal Blue turquoise mine.—The Royal Blue mine of the Himalaya Mining Company is in Nye County, Nev., 12½ miles N. 12° W. of Millers, and nearly 7 miles northeast of Crow Springs. The mine was owned and operated for a number of years by William Petry, of Los Angeles, and was sold to the Himalaya Mining Company in 1907. During 1908 and 1909 the property was systematically and actively worked under the direction of Julius Goldsmith for the Himalaya Mining Company. There are four claims at the main part of the mine and three others in the region.

These deposits are located among the hills on the eastern scarp of a plateau lying north and northeast of Crow Springs on the west side of Big Smoky Valley. The Royal Blue mine is about 5,400 feet above sea level, on a ridge extending west from a knob about 100 feet higher. The mine has been worked by 5 tunnels, 3 shafts, 3 open cuts, and some smaller pits. At the time of visit the tunnels were about 200, 115, 30, 30, and 20 feet long, respectively; the shafts were 20, 35, and 40 feet deep, respectively; and the open cuts were from 15 feet to 60 feet long, 25 feet wide, and 40 feet deep. The 200-foot tunnel was driven in from the hillside on the north to the main open cut at a depth of about 25 feet and was used to remove much of the rock from the open cut. There have been about 100 feet of crosscut tunnels driven from this 200-foot tunnel, one of the crosscuts connecting with a shaft. A raise was being made at the time of examination from the 200-foot tunnel to a pit on the surface above. The 115-foot tunnel was driven in from the northwest below the bottom of the 40-foot open cut, with which it connected by a chute. Two 30-foot tunnels and an open cut 20 feet square were made on the south slope of the ridge near the top and 80 to 100 yards southeast and east of the main open cut. A track with mine car was used in the 200-foot tunnel to remove waste, though the track was to be moved to the 112-foot tunnel.

The country rock is a fine-grained light-colored porphyry, which appears, under the microscope, to be an altered trachyte. The original feldspar crystals have been crushed and largely altered to sericite, and in places to kaolin. A few small scattered grains of quartz occur through the altered feldspars. These sericitized feldspars are inclosed in a very fine feldspathic groundmass, also partly altered. The thin section contains numerous square or rectangular holes surrounded by or partly filled with much limonite stains, evidently the remains of original pyrite crystals now weathered away. The decomposed trachyte is soft in places, but much of it has been hardened by silicification and by a ferruginous cement. Where free from iron stains the trachyte is light-gray to white, though much of it is stained brown by limonite along seams and through the rock. The rocks of the region have been badly broken and shattered with many resulting joints and fissures, which are now filled with quartz, limonite, and occasionally turquoise. Ledges of dense hard gray quartz, locally called "bull quartz" and resembling quartzite, outcrop over the country, especially on the ridges and hilltops. These ledges strike in various directions. Under the microscope this rock appears to be an altered phase of trachyte thoroughly impregnated with quartz or a highly silicified phase of the trachyte. Limonite stains are common in seams and through this "bull quartz." The same rock is found in smaller masses in the ground worked for turquoise. A few hundred yards west of the turquoise workings is an outcrop of a conglomerate-breccia stained green with malachite.

The turquoise occurs principally in seams and veinlets with an occasional lenticular or nodular structure and in nodules or irregular lumps in the rock. The veinlets and lenses range in size from a small fraction of an inch to over an inch in thickness; the nodules from small lumps to those an inch or two in thickness. Masses of turquoise filling brecciated matrix have been found 4 or 5 inches thick. Lens-shaped pieces of turquoise weighing an ounce or two are not uncommon, and one piece weighing nearly a pound and a half was reported. The turquoise varies in color from dark sky blue to pale blue. Some of the dark blue has a greenish cast and some has a nearly pure blue color. The dark-blue turquoise and that with a greenish cast is very dense grained and very hard. The lighter-colored variety is generally softer. The best hard turquoise is generally found in the harder limonite-stained rock, and the pale blue and softer turquoise is found in the light-colored soft trachyte. The quality of the best pure blue turquoise from the Royal Blue mine is probably equal to that of any other American turquoise, and the matrix from this mine is also especially fine. The hard turquoise veins and nuggets are coated with a crust or stain of dark to light brown and yellow limonite. This stain also penetrates the turquoise at intervals along seams and branching cracks, producing most attractive patterns and contrasts of color. A large specimen examined and photographed at the mine measured about 8 by 3 by 2 inches. This specimen consisted of a patchwork of dark-blue turquoise with a slight greenish tint in places in a very dark red-brown matrix. The cut gems from such a specimen should show splendid contrasts in mottled or turtle-back matrix.

The cut gems vary with the nature of the turquoise. The combinations of pattern and contrasts in colors exhibited by some of the matrix stones are very beautiful. One especially attractive set of colors consists of seams and splotches of light-brown and dark-brown matrix with an irregular fringe of dark-blue or sometimes slightly greenish-blue turquoise filled in with pale or baby blue turquise. In some specimens the brown matrix or darker blue turquoise assume a dendritic or bushy appearance in the lighter blue. The mine has yielded to both operators a large quantity of such gem material as described. Among polished gems from this mine seen in William Petry's office were slices 2 to 3 inches across and weighing 50 to 100 carats, for belt buckles, large brooches, parasol handles, and many smaller gems, all beautifully marked and colored. The better grade of matrix is retailed at $1 per carat.

Oscar Wehrend prospect.—Oscar Wehrend has tested a prospect about one-third of a mile north of the Royal Blue mine, across a draw. At the time of visit (August, 1909), there were two open cuts, 20 to 30 feet long, with a maximum depth of 12 to 15 feet. An old shaft near by, about 30 feet deep, had not been cleaned out. The country rock is trachyte badly altered and decomposed. It has been kaolinized without being much silicified or hardened by iron oxides. The loose rock thrown on the dump has slaked badly in the weather. "Bull quartz" ledges outcrop on the hillside above. The turquoise occurs through the rock, in seams, splotches, and nodules, which reach a thickness of 2 inches or more in places. The turquoise is mostly quite pale and rather soft, and further prospecting has not developed a much better grade of material. This turquoise is susceptible of having the color improved by artificial means, as during the process the turquoise becomes somewhat hardened and would serve for cheap grades of jewelry.

William Petry turquoise mine.—The William Petry turquoise mine is about three-fourths of a mile south of Crow Spring and 10½ miles N. 40° W. of Millers, Esmeralda County. The mine is in the summit of a small knob among the foothills on the east side of the Monte Cristo Mountains and about 200 to 300 feet above the lower country on the east or between 5,400 and 5,500 feet above sea level. The work has been more in the nature of prospecting than mining and consists of three small pits, one each on the east, north, and west sides near the summit of the hill. The cut on the north side is 50 feet long in a southerly direction, is 3 feet wide, and grades to 15 feet deep.

The hill is composed of very fine-grained porphyry or rhyolite, probably a portion of a flow extending back into the Monte Christo Mountains. Regular granite porphyry outcrops on the northeast side of the hill below the mine and may represent a coarser-grained phase in the interior of the porphyry flow. Hard ledges of silicified porphyry outcrop over the hill in a northeast direction. The chief constituents of the porphyry as determined in thin section are quartz and orthoclase with small amounts of epidote and zircon. The thin section contained many small holes such as might have formed where stout apatite crystals had been decomposed or ground out. Around the edges of some of these holes were small rims or patches of a mineral with a low birefringence and fairly high refractive index which were probably apatite. The section was cut from a fairly fresh specimen of the rock, though it contained a few clouds of kaolin and was traversed by several small seams of turquoise. Other portions of the porphyry on the hill are extensively altered and kaolinized and some are stained pinkish. The decomposed porphyry is somewhat silicified in places and stained with iron oxides.

The turquoise occurs in seams cutting the porphyry at all angles. Seams ranging from paper thickness to nearly half an inch thick were seen. In some places there are several seams in the space of an inch more or less parallel with one another or branching out or cutting across one another. In some cases the porphyry matrix is very fine grained and hardened by a siliceous or ferruginous cement. Such material cut by turquoise seams an eighth of an inch thick is especially adapted for cutting into cameos, and much of it has been used for that purpose. The turquoise ranges from pale blue to pure blue of a fairly dark color. Material that would yield gems of large size is scarce, though the best blue stones have a good color and are very hard. Some pretty turquoise matrix with brown and red markings are obtained.

Another prospect is reported to have been opened by William Petry and Oscar Wehrend, about a third of a mile to the northwest at the foot of another knob, where, it is said, more turquoise of good color and of more promising size was found.

Myers and Bona turquoise mine.—H. M. Myers and Charles A. Bona, of Millers, Nev., leased and worked a turquoise prospect on the Gilbert-Thompson property, 13 miles north of west of Millers, Esmeralda County. The mine is on the western slope of the eastern part of the Monte Cristo Mountains at an elevation of about 6,400 feet. The principal work was for gold and copper, for which the mine was opened, the turquoise being found later. The workings consist of a shaft 40 feet deep, a tunnel 75 feet long, with about 40 feet of drifts and stopes from it, an open cut near the shaft, and a few prospect pits. The mine is in the northeast face of a small steep hill.

The country rock is principally quartz porphyry, which incloses bands of black slate. The porphyry is strongly altered, the feldspar having changed almost entirely to sericite. In this section the quartz phenocrysts are seen to be badly crushed and shattered and inclosed in a mass of fibrous sericite. The black slate has slightly calcareous and siliceous phases, and part might be classed as jasperoid. Some of the black slate is soft and resembles graphitic phyllite.

The turquoise is found along the contact of the porphyry with a band of included slate. This body of slate strikes about N. 20° W. and has an irregular dip of 30° to 50° SW., and a ledge of silicified rock with a prominent hard outcrop cuts across it at right angles. The slate contacts and inclusions in the porphyry appear to be baked in places and to have altered and become soft in other places. The turquoise occurs in nodules and nodular seams or veinlets. The nodules range from a fraction of an inch to over 2 inches in thickness and the seams up to one-half inch in thickness. The seams of turquoise are not regular or continuous, but pinch and swell from small size into nodular lumps; some of the nodules of turquoise are scattered through the rock irregularly, while others occur in a lead inclosed in a softer gouge-like matrix. The best turquoise occurs in the black slate, generally in the softer decomposed streaks; some is found in the porphyry, but it is generally soft and not of good color.

The turquoise from this mine presents some peculiar features. The best material is hard and is a beautiful sky blue in color. Some specimens of the hard turquoise have also a greenish cast with the sky blue. Many of the nuggets, especially the larger ones, are pale blue and are deficient in hardness. These nuggets are very tough, however, and are difficult to break with a hammer. They appear to have a very fine felty fibrous texture, slightly resembling meerschaum, even when examined under the microscope. Iron stains are present with some of the turquoise, either along the walls of the seams or filling cracks in the mineral, and they add to the beauty of the matrix material.

The best turquoise from this mine is probably equal in color and hardness to turquoise from many mines in the Southwest. The output of the deep-blue turquoise is not large, compared with the poorer grades, and large specimens are scarce. Round balls of hard white mineral, having a fine texture and ranging up to 4 inches in diameter, occur through the porphyry. This material is a hydrous phosphate of aluminum, though its exact composition has not been determined. In texture and appearance it resembles white turquoise. The mine was worked during 1908, but was not operated in 1909 because of the trouble experienced in placing the gem material on the market.

Montezuma turquoise mine.—The Montezuma mine of the German American Turquoise Company is 12 miles N. 40° E. of Redlich, and about 20 miles by road east of Sodaville, in Esmeralda County. It is in the foothills on the east side of the Pilot Mountains, at an elevation of about 5,900 feet above sea and 600 feet above a large sand flat about 2 miles to the east. The deposit is in the north side of a small hill and has been opened by about a dozen pits and tunnels of irregular shape. Other croppings of turquoise have been found on the hill, but have not been opened.

The country rock is soft decomposed porphyry, probably trachyte. Andesite and traplike rocks outcrop in the region. Ledges of quartz or hard silicified porphyry also outcrop across the hill and in the surrounding country; many of them have a northeast strike and vary from a few feet to 15 feet in thickness; others cut the country rock at various angles. These porphyry and quartz ledges have been crushed and the joints filled in with brown to purplish stains of iron oxide. The turquoise occurs in the altered trachyte in seams, veinlets, and nodules which range up to an inch or more in thickness. The turquoise is quite variable in color and hardness, and ranges from hard, very fine dark blue to dark blue with a greenish cast to pale blue and soft material. There is much dark brown to yellow limonite stain associated with and filling fractures in the turquoise.

The best colors and the hardest stones are generally found in the hard iron-stained portions of the trachyte, and the softer pale-blue stones in the light-colored soft porphyry or trachyte. The best cut matrix gems from this mine resemble those from the Royal Blue mine in marking and color. Strong contrasts in brown and blue, with mottled patterns are obtained and yield beautiful gems. The bulk of the output is in low-grade gems which are retailed at about 50 cents per carat.

Moqui-Aztec turquoise mine.—The Moqui-Aztec mine, or the S. Simmons turquoise mine, is about a mile southwest of the German-American mine in the south side of a ridge at an elevation of about 6,250 feet above sea level or 350 feet above the valley below. The mine has not been operated since 1908 and the workings have fallen in so badly that a thorough examination was not possible. There were three or four tunnels, one of them 80 feet long, with irregular open cuts and pits. One of the tunnels was driven in from the opposite side of the ridge about 100 yards to the northeast of the mine workings. The 80-foot tunnel was driven N. 35° E. (magnetic) and apparently along a turquoise lead.

The country rock is rather fine-grained quartz porphyry, approaching granite porphyry, badly decomposed and kaolinized. Irregular masses of quartz outcrop on the hillside in and near the mine. Portions of the porphyry are stained with iron oxides, and the quartz is badly iron-stained. The turquoise occurs in veinlets and nodules in the porphyry and quartz, and that associated with limonite iron stains is generally the best in grade. A large amount of pale-blue turquoise has been obtained from this mine and cut at the owner's lapidary shop in Los Angeles. Turquoise of dark pure blue color is scarce and some of the paler variety is deficient in hardness. Pretty light-blue matrix stones with delicate brown markings have been cut in some quantity.

Smith black matrix turquoise mine.—The Smith black matrix turquoise mine is about half a mile south of the Southern Klondike mining camp and about 3 miles northeast of Klondike, a station with water tank on the railroad between Tonapah and Goldfield, in Esmeralda County. The mine is in a group of small hills, about 400 feet higher than the railroad, or about 5,500 feet above sea level. A conical-shaped knob one-third of a mile west of the mine has an elevation of about 5,800 feet and is quite prominent because of its white color and elevation. The workings at this mine are small and consists of three small cuts with a short tunnel on the northeast slope of a hill of dark rock.

The country rock consists of limestone and shales, with hard siliceous phases called jasperoid by S. H. Ball [a] and classified as of Cambrian age. The limestone is a dark gray and grades into jasperoid and slate. The latter rocks are fine-grained, gray to black, banded rock, with a more or less wavy bedding. The hardness varies with the extent of silicification. A few hundred yards to the south of the deposit is a mass of rhyolite, with quartz porphyry phases, whose northern boundary extends in an irregular east-west direction. This mass appears to be a flow, and probably once covered the turquoise deposits and surrounding rock. It has a very fine grain and contains phenocrysts of orthoclase and quartz. Near the lower contact there are frequent inclusions of other rocks. This rhyolite has been partly weathered in places and assumes a pinkish color. The general appearance of the country over the rhyolite formation

[a] A geological reconnaissance in southwestern Nevada and eastern California; Bull U. S. Geol. Survey No. 308, 1907, p. 77.

is light gray to white and is in marked contrast to the dark appearance of the limestone and jasperoid.

The turquoise occurs in seams and veinlets filling joints and fractures in black slaty jasperoid, which they cut at all angles. In places the jasperoid rock is badly brecciated, and here the turquoise fills in the spaces between the angular fragments. The seams range from the thickness of a sheet of paper to more than three-fourths of an inch. The brecciated masses with turquoise fillings may be an inch or two across. The thicker seams of turquoise generally contain angular fragments of black jasperoid. The turquoise seams, however, are very irregular in size and direction, and they branch from one joint plane to another at various angles. There is more or less limonite iron stain in the joints and through the rock, being in some places intimately associated with the turquoise.

The turquoise from this mine, little, if any, of which is sufficiently large to be cut into pure turquoise gems, has been handled by the California Gem Company, of Los Angeles. The output is entirely in matrix, which owes its beauty to the striking contrast between the blue turquoise and the black matrix in the innumerable patterns exhibited by them. In some of the cut stones the turquoise predominates, in others the black matrix. Some gems are cut with one or more seams or veinlets in matrix, others with fragments of matrix included in turquoise, and still others consist of badly brecciated matrix with a filling of turquoise. Brown iron stains are present in some of the gems and lend contrast. In other stones there are patches or seams of gray quartz, which blends well with the other colors.

The turquoise ranges from blue of a fairly pure color to very light blue to greenish. The greenish turquoise is difficult to distinguish from variscite in places, and may occur in seams in the same hand specimen with blue turquoise. The greenish variety does not react so readily for copper when tested by the flame coloration method, and some of it appears to contain very little of that metal. Under the microscope such material exhibits a texture resembling that of variscite—that is, it is concretionary and spherulitic—but it also appears to grade into a normal turquoise. It seems possible that there may be a gradation from turquoise to variscite through a more or less amorphous series of hydrous aluminum phosphates in which copper occurs in amounts varying from nothing to the several per cent necessary to produce normal turquoise. In this occurrence of turquoise the mother rock is similar to that in which some of the variscite is generally found, though there is the usual porphyritic rock characteristic of turquoise in the neighborhood, and it may have once covered the deposit of turquoise. Under such conditions the materials forming the turquoise could have leached from the porphyry during its decomposition into the broken jasperoid below. The copper necessary to supply the color of the turquoise may have come from copper minerals in the porphyry or from deposits in the jasperoid, in which a few copper stains were observed in one prospect near the turquoise mine.

Los Angeles Gem Company.—Turquoise has been found at two places on the variscite claims of the Los Angeles Gem Company, about 2 miles northwest of the deserted mining camp, Columbus, in Esmeralda County. One of these is at the west end of the group of claims on the Pirate No. 3 claim, and the other is a small knob about one-fourth of a mile south of the center of the line of claims. The rock formations and the general region are described under variscite in this report. In the first deposit mentioned a pit 5 feet deep and 15 feet long has been made in an east-west direction, following a seam of turquoise more than an inch thick a short distance in dark-gray cherty siliceous rhyolite. Part of this turquoise is fairly dark blue and quite hard. A little greenish variscite-like material was found in the same pit and is said to have come from the same veinlet as the turquoise.

At the other place two prospect pits were made in a dark jasperoid or silicified calcareous rock. Small seams of dark blue very hard turquoise with a slight greenish cast were found. These seams were not abundant, and none over half an inch thick were found, the majority being less than one-fourth of an inch in thickness. The very dark brown and black matrix with this turquoise would yield beautiful gems.

Little has been done with either of these prospects, as the company has been kept busy supplying the trade with variscite.

Other localities.—Turquoise has been found associated with variscite at other localities in Nevada. Among these are the claims of Carl Riek and W. K. Botts, 5 miles northeast of Coaldale, and of Clyde Carr and Mrs. Mattie Lovejoy, about 10 miles north of Blair Junction, both in Esmeralda County. Only a limited amount of work has been done on these deposits, though part of the turquoise found at each locality has a fine blue color. These deposits were visited in the spring of 1910 and will be described in the report for that year.

Turquoise was mined in Nevada during 1909 by Otto Taubert, 8 miles N. 75° W. of Yerington, in Lyon County. This mine was visited in May, 1910, and will be described in the report for that year. The turquoise occurs principally in seams and is a very hard variety. Some of it is a fine dark pure blue, and other is slightly greenish. Paler colors also occur, and much very pretty iron-stained matrix.

A collection of cut turquoise matrix from Belmont, Nye County, was examined in the office of William Kley, of Denver. This turquoise was obtained from Mrs. Eva S. Weber, of Belmont. The best grade consisted of dark-blue turquoise with a small amount of white mineral in a dark-gray and chocolate-colored matrix. The white mineral occurs as a fringe around the turquoise in many specimens and sets the turquoise with its chocolate-colored matrix off very beautifully. Along with this new variety of turquoise matrix was a larger quantity of ordinary blue, greenish, and brown matrix.

NEW MEXICO.

Turquoise has been mined in four regions in New Mexico. These are the Cerillos district in Santa Fe County, the Little Burro Mountains and the Little Hachita Mountains in Grant County; and the Las Cruces region in Dona Ana County. The best known of these localities are the Little Burro Mountains and Cerrillos. The turquoise from the best mines in these districts is famed for its excellence. In all four localities the turquoise deposits were once worked by the Aztecs or Indians and those near Cerrillos under Spanish rule.

LITTLE BURRO MOUNTAINS.

The turquoise deposits of the Little Burro Mountains, in Grant County, were described in this report for 1907. A brief visit was paid to the locality in July, 1909, to examine the recent work, the Azure mine being the only mine in operation. No new work had been done on the Parker mine and very little on the Porterfield mine. In the report for 1907 the distance by road from Silver City to the turquoise mines was given as about 15 miles; the new Silver City topographic sheet published by the Survey shows the Azure mine to be 10 miles S. 35° W. of Silver City. The mining camp is about 6,100 feet above sea level, and the Parker and the Porterfield mines are both about 6,000 feet above sea level.

The Aztecs or Indians operated some of the turquoise mines of the Little Burro Mountains as they did many other mines in the Southwest. The discovery of these deposits by white men dates back to 1885,[a] and although there is some dispute as to the original discoverers, the names of John E. Coleman, W. J. Foley, and Nicholas C. Rascome are prominent among those mentioned. The early work in this district was directed toward the remains of the Aztec mines with varying success. The Azure mine was discovered in virgin ground where there was no evidence of ancient mining.

Azure turquoise mine.—Mining operations at the Azure turquoise mine were begun in 1891 by the Azure Mining Company, of New York. The operations at this mine have been on a larger scale than at any other turquoise mine in the country, and the value of the production of turquoise is commonly stated to be from $2,000,000 to $4,000,000. The mine was worked by an open cut about 200 yards long, 100 to 200 feet wide, and over 60 feet deep in the deepest part, with adits on two levels below the openwork. There has been but little turquoise obtained from this old working during the last four years, though several shafts, crosscuts, and tunnels were driven in search of gem material.

During 1908 a new deposit of turquoise was opened about 150 yards east of the old mine by W. R. Wade, mining engineer of the Azure Mining Company. The mine is in the bottom and along the west side of a small draw. The deposit was once worked by the Aztecs, and their tunnels and openings filled with rubbish are exposed in the upper part of the mine. In the early days of turquoise mining in the Little Burro Mountains, M. W. Porterfield and associates prospected for the turquoise deposit near these old Aztec workings. The Porterfield tunnel missed the recently discovered deposit by a few feet only. The developments to the time of examination consisted of old openworks with tunnels, and recent shafts, drifts, winzes, raises, and stopes. There were two levels below the openwork. The first of these was the principal level and consisted of a tunnel about 260 feet long with three raises to the upper level, stopes, and a 50-foot inclined winze to the second level 30 feet lower. The tunnel was driven into the hill in a direction S. 25° W., nearly parallel with the course of the small valley. Mr. Wade stated that the development work amounted to nearly 1,200 feet. Mining operations are impeded during wet weather, as part of the openwork is in the bottom of the draw.

[a] Zalinski, E. R., Turquoise in the Burro Mountains, New Mexico: Econ. Geology, vol 2, 1907. pp. 4[illegible]-492.

The country rock of the region around the turquoise mines is principally granite porphyry presenting different phases from nearly ordinary quartz porphyry to porphyritic granite. Some monzonite occurs. At the Copper King copper mine, one-half mile southwest of the New Azure mine, the rock is coarse porphyritic granite, composed of large pink orthoclase and white oligoclase crystals, gray quartz, and biotite mica. At the Porterfield mine, one-half mile to the southeast, the same type of rock occurs along with some dark-gray speckled monzonite. The rock around the Azure mine and to within a short distance of the more recently discovered deposit is medium-grained porphyry, occurring both as quartz porphyry and as granite porphyry. This rock has been partly altered and silicified by the deposition of quartz in many joint seams and fracture zones and in the interstices of the rock. The occurrence of a large number of seams of gray quartz cutting the rock at various angles is quite characteristic. The rock is gray to pinkish gray and is fairly hard. It is the formation in which the turquoise deposits of the old Azure mine occurred. The rock in which the new deposit has been found is a pinkish-gray granite porphyry with a rather fine ground mass inclosing large phenocrysts of gray quartz and smaller ones of feldspar. The feldspar in the rock near the turquoise deposit has been badly kaolinized. The rock may represent a slightly different phase of the regional granite porphyry or a separate intrusion. In places this rock is cut by only a few quartz seams, but along the fracture zones and near the turquoise veins quartz is more abundant.

The turquoise is found in a belt about 80 feet wide in a fractured zone of the last body of porphyry described. The porphyry has been broken by a series of roughly parallel joints with a strike of about N. 25° E. (magnetic) and a dip of 30°–60° E. and by fractures in other directions. The turquoise occurs in veinlets and seams along these joints. Mr. Wade states that there are six prominent seams in the belt and numerous smaller seams in the cross joints. The prominent turquoise seams and veins are readily followed and hold out for greater distances than those in the branching or cross veinlets, in which the turquoise extends only a few inches from the main veins in some places and to several feet in others. Some of the veins carry no turquoise for distances ranging from a few inches to several feet and may then pass into nearly solid turquoise veinlets or quartz and limonite stain with turquoise nuggets or patches. Some of the seams in which the turquoise fails are filled with a clay gouge-like material with or without iron oxide stains. In places seams of turquoise pass into nodular turquoise, the nodules lying loosely fitted together, being apparently the result of fractures in a once solid seam. These nodules range from small size to 3 or 4 inches in diameter. Those the size of a walnut are not rare. The seams and veinlets of turquoise range in thickness from a small fraction of an inch to over 2 inches, and the veins along the main joints are much thicker than this. They are not composed wholly of turquoise, however, and may contain considerable matrix and quartz. The turquoise seams occur both in hard silicified rock and in decomposed rock, with or without red hematite or brown limonite stains. Some of the seams are in gray porphyry without any associated minerals. The quality of the turquoise does not seem to vary greatly with the matrix unless decomposition has been extensive, when it may be discolored and altered. Representative specimens of discolored turquoise were kindly sent to the Survey by Mr. Wade for examination, and similar material was observed during the investigation of this mine and others in the region. Some of these specimens are composed of nodules of blue, bluish-green, and greenish turquoise with a core or shell of greenish-brown or brown turquoise; in other specimens the whole nodule is greenish-brown or brown. The same mottling and texture are common to the blue turquoise and to the brown. The green and brown colors are due to the presence of iron, as is shown by treating fragments of the mineral in boiling strong hydrochloric acid. In this operation the discoloration is removed, and pale-blue to nearly white, rather soft turquoise is left; the resulting solution contains iron, copper, phosphate, and probably aluminum. When pure green turquoise, both light and dark colored, is treated with acid, the green color is removed and pale-blue, soft turquoise is left. Hard, dark-blue turquoise is not so readily attacked, though the color is much weakened and some copper is taken into solution.

The color of the turquoise from the New Azure mine varies from dark-blue, sky blue, light or baby blue to nearly white, to blue with a greenish cast, to green, to greenish-brown, and to brown. Pure turquoise is obtained in pieces of size sufficient to yield large gems. The matrix presents considerable variation; in one type there is turquoise of two colors—often a light-blue with darker blue or greenish mottlings or round spots peppered through it, or there may be a gradation from one shade of blue to another or to green or brown; another type contains inclusions of quartz or wall rock, with or without iron stains, and seams and dendritic markings of brown and yellow stains. Veinlets of turquoise in the country rock, or turquoise fillings in brecciated zones with or without red or brown iron stains also produce attractive combinations.

The turquoise from the Azure mine holds an enviable position in the gem trade. The pure blue cut stones are marked with a circle on the back and are guaranteed to hold their color for many years. The matrix is not guaranteed and is not generally sold as the Azure product. The finest material from the old mine came from one large pocket and was called "Elizabeth" turquoise. The best turquoise from the new mine does not equal the "Elizabeth" variety in color or quality, though it is about equal to that from the other parts of the old mine. The yield from the new mine is satisfactory as regards quantity.

LITTLE HACHITA MOUNTAINS.

The turquoise claims in the Little Hachita Mountains, about 6 miles west of Hachita, in Grant County, have several owners. According to Sterling Burwell, an old resident of the Little Hachita Mountains, the first work done on the turquoise deposits of this region was by Con Ryan and himself between 1885 and 1888. This work was done for gold, as Con Ryan supposed that the ancient workings and dumps in the region were gold mines of the Aztecs or early Spaniards. Turquoise was found, and four claims for this mineral were then taken up by Harry Wood, who soon sold out to eastern purchasers. Archie Young then located all the ancient workings. Assessment work was kept up on a few of these claims only, and in June, 1908, George W. Robinson relocated four of the best claims, in which

M. W. Porterfield was given a half interest for financial assistance; these claims were operated during 1909, the first turquoise mining in the region for several years. Other claims are now owned by the American Turquoise Company, of New York, by M. M. Crocker, of Lordsburg, by the Mary Posey Mining Company, of San Antonio, Tex., and by R. S. Chamberlain.

For a few years from 1880 on there was a lively mining camp in this part of the Little Hachita Mountains, and a silver smelter was built about a mile east of the turquoise deposits. It is said that a little turquoise was found in some of the silver mines of this region. Turquoise is reported to have been worked several years ago by Nick Rascom at Silver Night, about 20 miles to the southwest of the present mines. This work was on old dumps, the remains of some of the old Aztec workings, which are numerous in the Little Hachita Mountains. Around one of these were a large number of stone hammers of crude workmanship. A thin section for microscope study from one of these hammers shows it to be an andesitic breccia or tuff. The hammer is greenish gray and is very tough; the material for it was probably obtained near the locality where it was used.

The Little Hachita Mountain turquoise deposits lie at elevations of 5,000 to 5,400 feet above sea level, or about 500 feet higher than Hachita. The claims are located in a semibasin country open on the east side of the mountains for about 3½ miles north and south and for 2½ miles to the east. The basin is surrounded by rock-capped hills from 600 to 1,000 feet higher on the north, west, and south than on the east, where low hills slope down to a large flat toward Hachita. The drainage is to the east in channels cut through these low hills. There are several small knobs, ridges, and spurs in the basin higher than the hills on the east. Prominent among these knobs is an elongated ridge nearly half a mile long in a northeast-southwest direction and slightly northwest of the center of the basin. This hill contains numerous turquoise deposits, especially at the northeast end, and is sometimes called Turquoise Mountain. In the description of the different turquoise prospects in the region locations will be given by distance and direction from the summit of this hill at its northeast end. The higher rim of the basin is a scarp with cliffs and steep slopes on the inner side.

The country rock of the region consists of a series of interbedded sedimentary, volcanic, and intrusive rocks. The sedimentary rocks are sandstone, slate, or phyllite, and limestone; and the volcanic rocks are rhyolite, trachyte, and andesite, which occur as breccias or tuffs, flows, sills, and dikes. The structure of the formations on the south and southwest rim of the basin is monoclinal, with a light dip westerly and away from the basin and a strike to the northwest. Whether this monoclinal structure continues up the west side of the basin to the north end was not determined. The southwest rim of the basin is composed of a heavy bed of gray cherty limestone. Below it are slates and beds of andesitic tuff, with trachyte near the base of the hill. Still lower in the series and in places in the bottom of the southern half of the basin are beds of volcanic tuff, rhyolite, limestone, slate, and greenish sandstone. A large area of the basin is occupied by trachyte, andesite, and probably monzonite, especially in the northern half. These rocks probably occur partly in the form of sills interbedded with the sedimentaries and other volcanic rocks, and partly as dikes or stocks. In the higher parts of the basin they remain uneroded, while in the lower parts the underlying rocks are exposed. The trachyte, andesite, and monzonite rocks are closely associated and both exhibit fine to medium-grained texture. Large areas of the trachyte are so decomposed that its original nature is uncertain. The turquoise deposits are associated with the altered trachyte and probably with altered andesite. In one of the mines a dike of altered porphyry, probably monzonite, was encountered. The low hills on the east of the basin are capped with cherty limestone, which may be the same formation as that on the west rim of the basin, dropped down by a great fault.

Robinson and Porterfield mines.—The claims owned by George W. Robinson and M. W. Porterfield are the Azure, along the top of Turquoise Mountain; the Cameo, nearly 1 mile north of west of the northeast end of Turquoise Mountain; the Galilee, three-fifths of a mile southwest of Turquoise Mountain; the Aztec, 1½ miles west of south of Turquoise Mountain.

There have been two sets of workings on the Azure claim, one at the northeast end of Turquoise Mountain and the other near the middle of the hill on the top. At the northeast end there were the remains of ancient Aztec workings, mostly filled in, and the prospects of the first white miners. Recent work consists of a tunnel about 160 feet long with a crosscut and stopes connecting with an open cut on the surface. The tunnel was driven in southwest from the northeast end of the hill, and near the end a crosscut was run to the southeast connecting with stopes to surface work above. This drift also encountered Aztec workings, mostly filled in with rubbish, and workings of later people, either Spaniards or early miners during the eighties. This latter excavation consisted of a drift about 35 feet below the surface with the old entrance completely filled with rubbish. This rubbish was either purposely filled in the exit by the early miners to conceal the deposit or has slipped in by the breaking down of the walls. The presence of a small rusted tin can in the bottom of the hidden tunnel and round drill holes suggests a later period of mining than that of the early Spaniards. The open cuts at the surface above were made by former miners and followed the Aztec workings.

The turquoise occurs near the contact of very fine-grained trachyte and a porphyry, probably monzonite, both badly decomposed. The contact of these two rocks extends northeast and is quite irregular. The turquoise is found mostly in the trachyte, especially where the latter has been fractured and stained with iron oxides. The rock has been badly broken and the turquoise fills the fractures with irregularly shaped seams ranging from a very small fraction of an inch to half an inch in thickness. These seams branch and cross one another and open abruptly out from small size to large size. Where the rock is very badly fractured the joints are sometimes all filled with turquoise forming masses of matrix of good size. The matrix is harder where strongly stained with yellow and brown iron oxide, and in combination with the fine color of part of the turquoise it makes beautiful matrix gems. The turquoise ranges in color from dark sky-blue to pale blue and greenish blue. The dark blue and the greenish blue are very hard; the pale blue variety is rather soft. The principal yield from this claim is in matrix turquoise with some good cameo material.

At the southwest end of the Azure claim two open cuts were made in a northwest direction. These cuts were in trachyte rock and exposed seams of turquoise having a northeast strike. Other veinlets of turquoise outcrop along the ridge near by, associated with limonite stains. Some very hard turquoise with a fine pure blue color was found in the seams in heavily iron-stained rock.

On the Cameo claim a shaft has been dug 40 feet deep and drifts with stopes run from it in a northeast-southwest direction. These drifts and stopes were made on a prominent veinlet of turquoise which strikes northeast with a vertical dip at the surface and inclines at about 75° NW. from a depth of 20 feet to the bottom. The inclosing rock is a yellowish-gray altered trachyte. On the hill above is a massive outcrop of hard, dark andesite. In the bottom of the shaft the best turquoise has been found in a band of rock 7 feet wide lying between two prominent joints or veinlets with a northeast strike and a high northwest dip. Other seams of turquoise occur in varying positions, some lying nearly horizontal and others striking northwest. It is said the best turquoise has been found at points where some of these side seams cross the main veinlets. The turquoise occurs principally in veinlets and seams, the largest half an inch thick. These veinlets are hard and firmly attached to the wall rock, which is sufficiently hard to serve as a matrix, and some of the turquoise is cut into cameos with it as a base. The wall rock of the seams is yellowish-gray to brownish in color. The best turquoise has a good pure blue color, locally passing to greenish-blue. This deposit was originally worked by the Aztecs and remains of their work with their stone hammers are still to be seen near the present openings.

The work on the Galilee claim consists of a large shaft or a small irregularly-shaped pit about 20 feet deep. The rock formation is altered trachyte of fine grain and strongly stained with iron oxides. The turquoise occurs in two main veinlets or seams and in a few smaller less pronounced ones. The veinlets are fracture zones strongly stained with limonite, having turquoise in spots or in small rounded grains distributed throughout.

The Aztec claim is on the northeast slope of the southwest side of the basin about 500 feet below the rim. There were Aztec workings on this deposit, and a tunnel was run under them by Harry Wood. Some stoping was done in this tunnel. Mr. Robinson has made a new opening above Harry Wood's tunnel and to the south of the Aztec workings. The deposit is in decomposed trachyte in part stained and hardened by iron oxides and in part still light-colored and soft. On the hill above the mine there is a ledge of heavily pyritized trachyte. The turquoise is found in seams filling pronounced joints and generally associated with limonite stains, and in balls or nuggets in leads through the trachyte or isolated. The nuggets are said to yield better turquoise than the veinlets. Streaks of gypsum occur in the trachyte near the turquoise leads. The turquoise from the Aztec claim is not of so good grade as that from some of the other claims. Much of it is rather soft and pale. Some of the turquoise with good color when fresh fades somewhat on exposure.

American Turquoise Company mine.—The American Turquoise Company mine is a little over 1 mile north of west of Turquoise Mountain and a few hundred yards west of the Cameo claim. This mine was opened by a shaft 60 feet deep with a drift and raise to an open cut, and by another open cut about 150 yards to the north. The country rock is fine-grained light-gray to grayish-yellow stained altered trachyte. Specimens obtained from the dump contained inclusions of darker rock also altered. These inclusions may be from the lower part of the trachyte sill where fragments of the underlying andesite were caught up. The workings are in a direction of N. 10° E. and evidently followed a pronounced vein or set of veins, the dip of which is about vertical. The turquoise has been deposited in a fracture zone in veinlets and seams. It is said only pure turquoise was obtained from this deposit and that there was little material for cutting into matrix. The best turquoise has a good blue color and is quite hard.

M. M. Crocker claims.—The M. M. Crocker turquoise claims are the Azure No. 2 on the southwest end of Turquoise Mountain, and the Twilight, on a small knob one-half mile south of west of Turquoise Mountain. The work on the Azure No. 2 claim consists of a shaft 40 feet deep and an open cut at one place and an 8-foot pit a few hundred yards to the southwest. The 40-foot shaft was sunk in decomposed trachyte with andesite near by on the east. A strong seam of turquoise running about N. 25° E. and vertical was encountered. In the pit several smaller seams of turquoise with about the same dip and strike were found in altered trachyte.

The Twilight claim was opened by Mr. Robinson for Doctor Crocker by two pits. The country rock is trachyte and contains a few small seams of turquoise. Much of the turquoise is greenish blue, and the seams are bordered with heavy stains or films of limonite.

R. S. Chamberlain mine.—The Calmea claim of R. S. Chamberlain is on the east side of the northeast end of Turquoise Mountain. The deposit was marked by large Aztec workings, and has been tested by pits by several prospectors. A 40-foot shaft sunk by Mr. Chamberlain with a drift to the east is reported to have encountered ancient workings to that depth and so extensive as to make further mining difficult. The deposit appears to be along the contact of trachyte and monzonite or andesite. Little was seen of the formation or of the quality of the turquoise found.

Mary Posey Mining Company mine.—The mine of the Mary Posy Mining Company is about one-third of a mile north of Turquoise Mountain. A shaft was sunk at this point for silver. Turquoise was reported as found in this shaft.

Another claim, called the Le Feve claim and owned by parties in Clifton, Ariz., has been opened across a draw a little over half a mile S. 20° W. of Turquoise Mountain. A little turquoise was found here in soft decomposed trachyte.

VARISCITE.

The use of variscite in jewelry has increased greatly during the last two years and has created a considerable demand for good gem material. The growth of popularity of this gem is due to the appearance on the market of matrix material exhibiting a large variety of pleasing colors with innumerable combinations of patterns or markings. The two deposits of variscite first mined for gems in Utah were described in this report for 1908; namely, the utahlite or chlorutahlite mine of Don Maguire, of Ogden, and the amatrice mine of the Occidental Gem Corporation, of Salt Lake City. The occurrence of a variscite mine in southwest Utah, owned by John A. Maynes, of Salt Lake City, and a new discovery in Esmeralda County, Nev., were also mentioned. The latter locality has been taken up by the Los Angeles Gem Company and was examined in August, 1909. A description is given below of the deposits owned by this company. Since the operations of the Los Angeles Gem Company were started deposits of variscite have been located at several other localities in Nevada, and at one other in Utah. A number of these were examined in May, 1910, and will be described in the report for that year. The properties in Nevada are those of G. E. Wilson, Abner Capps, Carl Rick, and W. K. Botts, a few miles to the north of Coaldale; of Clyde Carr and Mrs. Mattie Lovejoy, 10 miles north of Blair Junction; of Mrs. Clara Dunwoody, C. M. Dunwoody, and C. Prichard, 8 miles southwest of Sodaville. The variscite deposit near Candelaria which has been known for a number of years was also examined. The title to this deposit is under dispute. At the time of examination the name of George W. Brown, a Cherokee Indian, was posted on the location monument, though it was reported that the property had not been given up by E. J. Tilden, of Goldfield, a former owner. In Utah a new deposit of variscite of bright green color and in large masses was located by Frank Edison and Edward Bird, 5 miles northwest of Lucin. A description of this deposit also will be given in the report for 1910.

NEVADA.

The variscite deposits of the Los Angeles Gem Company are in two groups. One of these is about 2 miles west of Rock Hill siding of the Tonapah and Goldfield Railroad, between the stations of Redlich and Coaldale. The other and larger group is about 1½ miles northwest of the deserted mining camp of Columbus. Columbus is about 5 miles southwest of Rock Hill, on the west side of the Columbus borax salt marsh. The two variscite localities are about 2 miles apart in a northeast-southwest direction. They are in the foothills on the east side of the Candelaria Mountains at elevations ranging from 4,700 to 5,200 feet above sea level, the elevation of Columbus being 4,625 feet. In the notes given below magnetic readings are used, the variation being nearly 18° east of true north. The line of hills in which the deposits occur have a north of east trend, with the main drainage lines crossing them in a southeasterly direction. The hills are in part very rough and rocky with smooth surfaces in places, in a measure due to outcrop of softer rocks. The mining camp of Columbus is on a large alluvial cone, sloping gently to the salt marsh on the east and at the mouth of one of the larger valleys from the mountains on the west. Thirty years ago there was a population of several thousand people at Columbus; at present it is occupied by a few gem miners or occasional prospectors only. Of the numerous well-constructed adobe houses once standing in Columbus there are still some ten or a dozen in fairly good condition, although the majority have slowly fallen to pieces after the woodwork was removed for fuel or buildings in adjoining camps by prospectors. The ruins in the dry desert region, with its scant vegetation of scattered sage-brush bushes, its white salt marsh, and the snow-capped White Mountains of California in the distance, are most picturesque. A supply of good water, though somewhat sweetish from the presence of borax, is obtained at a shallow depth from the wells of the deserted town, and is used by prospectors for miles around.

The variscite deposits were discovered by L. A. Dees, of Los Angeles, Cal., and Edward Murphy, of Esmeralda County, Nev., early in the spring of 1908. The discovery of new deposits was made at intervals until some half a dozen claims had been located. These claims were later sold to the Los Angeles Gem Company. While the claims were being operated Mr. Dees discovered a new deposit near by, and this was also taken over by the Los Angeles Gem Company. The deposits were operated for a short time by Messrs. Dees and Murphy, and later by John Caswell, a turquoise miner from Mineral Park, Ariz.

The variscite claims owned by the Los Angeles Gem Company are the Turquoise Butte or Robin's Egg, the Brownie No. 2, the Pirate, the Pirate No. 2, the Pirate No. 3, the Pirate Fraction, and the Emerald. The Turquoise Butte or Robin's Egg, as it is sometimes called, covers the variscite deposits to the northeast of the larger group of deposits. The Brownie No. 2 claim is about 1 mile northwest of Columbus and half a mile southeast of the main line of variscite deposits. The other claims include a number of variscite deposits in a belt 1 mile long in a north of east and south of west direction, and a few hundred yards wide. In order of occurrence from east to west these claims are—the Emerald, the Pirate Fraction, the Pirate, the Pirate No. 2, and the Pirate No. 3.

The development work necessary to secure a quantity of variscite has not been large, and at the time of the first examination there were no openings over 10 feet deep. Most of the work was in the nature of prospecting and location and consisted of pits and trenches, the largest 8 feet deep, 10 feet wide, and 25 feet long. The mining of variscite does not require extensive equipment or work, but the hardships attending the life in the desert in a large measure offset these advantages.

The rock formations of the variscite region consist principally of massive siliceous or cherty limestone and slate, rhyolite tuff, and slaty rhyolite, and sandstones or sandy shales and shales. Small bodies of altered trachyte occur near some of the deposits, and a little biotite granite porphyry was observed to the south of the gem claims. The formations encountered in a traverse from Columbus to the northwest are a large belt of limestone with some associated rhyolite, rhyolite tuff with slaty rhyolite, and sandstones and shales. The limestone is dark-gray to nearly black and contains many cherty and siliceous phases which may be called jasperoid. The rhyolite tuff is dark gray and presents coarse phases resembling conglomerate with angular fractured pebbles. The slaty rhyolite is a hard light to dark gray rock, and often exhibits flow banding; it is dense-grained to cherty in appearance and is sometimes difficult to distinguish from siliceous phases of the limestone and slate. The sandstones and shales outcrop in the higher hills to the north of the deposits where they probably overlie the continuation of formations just described. These sandstones and shales are gray to buff and red.

The trend of the formations varies from east and west to northeast and the dip is principally to the north and northwest, along the main line of deposits. Local variations of both dip and strike occur. There has been considerable faulting in the region, and some of the hills are evidently formed by block faults with the fault planes forming scarps facing east and southeast. Besides these larger faults the formations have been badly fractured and brecciated with a subsequent mineralization by silica and other minerals in the fissures. Silicification along these fractures has resulted in hardened rock which outcrops as prominent ledges. The outcrop of the limestone is generally very rough, especially along siliceous or cherty ledges. Much of the rhyolite forms rather smooth appearing hills whose surfaces are covered with sharp angular and shell-like fragments of rock that are exceedingly hard on shoe leather. Ledges of silicified, slaty rhyolite and tuff form very rough outcrops on the hilltops and slopes.

The variscite deposits occur in the limestone, rhyolite, and sandy shale formations, and some are associated with small trachyte dikes. The variscite occurs as a filling in fissures and joints replacing other minerals, and as segregations in the altered rocks. In the fissures the variscite not only fills the seams and joints but the crevices between shattered and brecciated fragments of rocks along the fissures. Thus brecciated zones several inches thick may have several main veinlets of variscite with numerous small seams and irregular patches of variscite between them. Some of the larger veinlets can be traced for many feet; the smaller ones are less persistent and vary in direction. The different deposits seem to bear little relation to one another and no definite veins of variscite are found through a distance of many yards. The individual seams and veinlets of variscite vary from paper thickness to 2 to 3 inches in width. The variscite-bearing streaks and breccia zones may attain a thickness of over 2 feet. The replacement and segregation deposits are nodular growths of variscite and allied phosphate minerals in more or less altered and porous rock. There is a tendency to nodular segregations along many of the veinlets, and some of the latter pass into nodular variscite lumps scattered through the rock. The more prominent veinlets of variscite generally occur in joints or fissures with a northeast trend and a vertical to high northwest dip. In some of the prospects the deposits are quite local and can not be traced more than a few feet in any one direction.

A feature common to the occurrence of variscite in the different localities is the tendency toward lenticular and nodular segregations, both of the variscite and of other minerals associated with it. Of the associated minerals there are allied phosphates, some of which may be variscite of different color from that ordinarily found. It would take a quantitative chemical analysis to determine the nature of each of these, and there might then be found a series of phosphate minerals with gradations from one to the other, still only determinable by chemical analysis.

The Turquoise Butte or Robin's Egg claim is located across a small rocky knob or summit at the end of a southward-extending ridge. There are several seams and veinlets of variscite outcropping within a distance of 75 feet of the main deposit. At the latter place there is a larger vein, ranging from a fraction of an inch to 3 inches in thickness, that has split into two smaller veinlets. The veinlets have a variable strike of N. 30° to 50° E. and a high northwest to vertical dip, cutting across the inclosing rocks at a small angle. The deposits are in dense chert-like rhyolite. A few hundred feet to the north is a wide area of buff-colored shales, and to the south hard siliceous limestone or jasperoid. The seams of variscite are irregular in thickness and continuity and in places are composed of nodular lumps and disconnected lenses of variscite with a chalky filling between them. In places, where the veins are widest, they contain more or less brecciated wall rock inclusions in the variscite. These inclusions may be ordinary dark-gray rhyolite or more or less brown iron-stained fragments. The color of the variscite from this deposit ranges from pale green to fairly dark green. Pure green stones can be cut weighing 25 carats or more, and much larger mottled and matrix specimens can be obtained. The Robin's Egg claim has been a good producer and has been worked to a depth of 20 feet during 1910.

The Brownie No. 2 claim is in a low-lying bed of siliceous limestone or jasperoid in the bottom of a wash only a short distance above the upper edge of the cone of drift material extending down to Columbus. The variscite occurs in seams, veinlets, and nodules irregularly distributed through the inclosing rock, which has been badly brecciated and lime and iron oxides have later been deposited in the fractures. The variscite ranges in color from nearly white to pale green and yellowish green. The massive portions of the veins are marked with fine irregular mottlings in places, and some of the variscite incloses irregular fragments of the wall rock.

The Emerald claim has proved an especially good one in both quality and quantity of output. A share in this claim has been purchased by the Verde Gem Company, of Los Angeles, and the two companies operate the claim together. Only a small pit in a low nearly flat ridge had been made at the time of examination in 1909. A hasty visit was made in 1910 to this claim, at which time there was an 18-foot shaft and a pit 20 feet long, 10 feet wide, and 8 feet deep. The country rock around the deposits is hard chert-like rhyolite, which strikes east and west with a dip of 25° N. The variscite occurs in veinlets cutting across the rhyolite with a northeast trend and a nearly vertical dip, and in nodules and ball-like segregations. The veinlets pinch out or are replaced by nodular and lenticular segregations of variscite. The balls and nodules range up to 2 inches in diameter and the seams or veinlets to over an inch in thickness. These masses are composed of dark-green variscite, inclosed in a black matrix. The variscite is in rounded lumps and irregularly shaped patches completely enveloped in veins and balls of black matrix. The black matrix may be black variscite, for t contains alumina, phosphoric acid, water, and a little iron; the texture also somewhat resembles that of variscite. Some of the nodules are composed of black variscite or phosphate alone with no green parts. Others are principally black with shotlike mottlings of dark grayish-green variscite, scarcely visible in the black. The variscite nodules are reported to be scarce in the lower parts of the openings, though the veins hold out well and exhibit the same patterns as found in the variscite. The nodules found near the surface are probably weathered fragments of segregations in the veinlets.

Outcroppings of other veinlets and nodules of variscite have been found on the Emerald claim. At one place pure white nodules 2 to 3 inches across were found. This material may be white variscite or an allied phosphate mineral, as it contains some of the same elements as variscite. At another point variscite or an allied mineral, pale-green to white in color, occurs closely associated with an altered trachyte dike. This trachyte is crowded full with pisolitic balls and small nodules of the variscite-like mineral and is further stained with yellow phosphate films in the seams.

On the Pirate Fraction claim a very similar occurrence of pisolitic variscite or phosphate mineral has been found in an altered trachyte dike 6 inches to 2 feet thick. The rhyolite adjacent to the trachyte has also been decomposed and has innumerable oolitic and pisolitic segregations of dark grayish-green phosphate scattered through it. These oolites have a radiated spherulitic structure and between crossed nicols under the microscope are seen to be true spherulites with a negative character and a fairly high birefringence. Between the two occurrences of pisolitic variscite or phosphate is an outcrop of sandy gray rock, that may be shaly sandstone or altered rhyolite, in which are many augenlike concretions of a yellowish mineral. These augen or lenses range up to an inch in thickness and are composed of yellowish phosphatic mineral.

On the Pirate claim variscite has been found at four different places in different modes of occurrence. The principal rock with which the variscite is associated on this claim is rhyolite, in places hard and chertlike and in others decomposed and soft. This rhyolite strikes about east and west with a 20° to 30° dip to the north. A trachyte dike about 1 foot thick cuts across the formations. The deposits are along the top of a ridge and in the low draw on the north. In two openings near the top of the ridge the variscite is found as shells coating balls of soft gray decomposed rhyolite, and also in patches through these balls. The latter range in thickness up to 2 inches and in some cases have no variscite associated with them. The variscite associated with these decomposed rhyolite segregations has a good green color, but there is little of it in sufficiently large pieces for cutting and the matrix is too soft to cut with it. In an open cut near by a pale-green variscite in many small nodules composing larger ones presents a cobweb or turtle-back effect. A few very thin seams of variscite were found in the less altered rhyolite in these cuts. Fifty yards farther north, down the hill, a stringer of variscite, three-fourths of an inch thick in places, was found cutting across the country rock with a northeast strike and a 50° dip to the northwest. The best variscite on this claim was found in two prospects, about 100 feet and 400 feet, respectively, east of the last-mentioned opening. In the first prospect dark-green variscite with black mottling occurs in one main veinlet, with irregular branch seams. In the other opening deep-green variscite occurs in a vein inclosing a dark-gray and black breccia matrix.

The Pirate No. 2 claim is farther west along the ridge in which the Pirate claim is located. The backbone of this ridge is composed of a ledge of hard silicified rhyolite tuff and breccia resembling a fractured conglomerate. The ledge strikes north of east and the same formation forms small knobs along this line for nearly a mile to the west. The variscite deposits are near the west end of the ridge on the south side of the tuff-breccia ledge. Five small cuts were made exposing one prominent veinlet of variscite, nodular variscite, and several small seams. Some of the variscite in the main vein has a nodular form with a chalky filling between the nodules. The latter are built up of numerous smaller lumps or balls with a brownish filling between them. These give cobweb or turtle-back effects when cut. Considerable pale-green solid variscite is also found.

On the Pirate No. 3 claim little if any variscite has been found. The veinlet prospected is turquoise and has been described under that mineral. The turquoise veinlets have a greenish color in places like that of variscite. When tested by the flame coloration test copper was found present even in the greenest material, so that it can not be variscite, but is more nearly turquoise.

The numerous variations in shades of color and in manner of occurrence of the variscite in the different deposits furnish material for a large variety of cut gems. The variscite ranges in color from greenish-black to deep emerald green, bluish-green, yellowish-green, light green, and pale green grading into white. Some of it is mottled with two or more of these colors. The matrix ranges from black to dark and light brown, yellowish, dark and light gray, and white. More than one of these colors or shades of color often occur together. Varieties of patterns are produced principally by the matrix in the variscite, though some of the mottled variscite of more than one color gives pretty effects. The markings due to the matrix vary with the conditions under which the variscite is formed. Where a brecciated zone was filled in with variscite the gem material may show inclusions of angular fragments of varying size of dark or light gray rhyolite, with or without brown or yellow iron stains. In other specimens the matrix predominates and the variscite occurs in one or more veinlets cutting through it. Some of the finest gems are obtained from matrix deposited with the variscite in the veins and nodules or in later fractures formed in them. The matrix may consist of cherty silica, phosphates allied to variscite, iron oxides, and other materials. These may occupy large portions of the gem material or may fill thin fractures or branching seams. The effects obtained by cutting such matrix are varied and beautiful. The nodules and veins of black phosphatic mineral with inclusions of deep green variscite patches from the emerald claim is probably the finest matrix cut by the company. The dark-green stones with delicate seams of black, sometimes with nearly dendritic structure, are also very beautiful, and much the same may be said of similar stones with brown markings. Lighter shades of green to nearly white with good markings, as in the turtle-back material from the Pirate and the Pirate No. 2 claims, are much admired. The pale-green and the yellowish-green variscite with the delicate markings, as found in the Brownie No. 2 claim, finds many admirers.

MISCELLANEOUS GEMS.

UNITED STATES.

SATELITE.

California.—The new gem "satelite," placed on the market by the Southwest Turquoise Company early in 1908, has been very well received in the Southwest. The cabochon-cut stones give an excellent cats'-eye effect and the dull green color is pleasing. Satelite is serpentine pseudomorphous after amphibole, probably the tremolite variety. The rough mineral looks very much like low-grade asbestos, though the fiber is not so fine. It is a magnesium silicate containing water, which distinguishes it from amphibole. The refractive index is much lower than that of tremolite or about that for serpentine.

Satelite is obtained from the south end of Venice Hill, 8 miles east of Visalia, Tulare County, Cal. This locality has been partly described under chrysoprase. The deposit was discovered in 1897 by Jerome Prethero while prospecting for asbestos. The possible value of this serpentine as a gem was not considered for ten years after the deposit was discovered. Only a small amount of work was necessary to secure satelite sufficient to supply the early demands of the company. When visited in August, 1909, the work consisted of a pit about 15 feet long and 4 feet deep with a northeast trend. The rock around the deposit is complex and consists of both serpentine and soapstone. The country rock at the south end of Venice Hill is serpentine, with beds of chloritic schist and talcose soapstone. The vein carrying the satelite is lenticular, pinching down to an inch or two in thickness near the ends of the cut and swelling to nearly a foot thick at the middle. The satelite does not occur in compact pure masses, but in lenticular and flat sheets with weather stains around them, or with one portion nearly pure satelite serpentine and the adjoining part silicified and hardened by chalcedony. About 150 yards south of west of the satelite deposit a vein of dull green chalcedony 6 inches thick has been found in a serpentine outcrop. This material shows small concentric agate-like growths with radiated crystalline centers through greenish chalcedony resembling prase. A small amount of strongly silicified satelite was found with this. It is possible that this greenish chalcedony would cut into attractive forms. Satelite is retailed at 50 cents per carat for the poorer grades and at $1 or more per carat for the best grades.

APRICOTINE, CREOLINE, VERDOLITE.

Three varieties of miscellaneous gems have recently been introduced by Louis J. Deacon, of Atlantic City, N. J. These stones are used principally for the tourist trade and would be very useful for the arts and crafts work. They have been called "apricotine," "creoline," and "verdolite." Mr. Deacon kindly loaned samples of the cabochon-cut stones for examination and furnished rough specimens of each, along with notes on their occurrence.

Apricotine is cut from flattened waterworn quartz pebbles, which have delicate reddish and yellowish-red tints of color resembling those of a ripe apricot. These pebbles are found about 2½ miles above Cape May, on the New Jersey shore of Delaware Bay, on a portion of beach generally covered by water. When the tide is very low a few pebbles suitable for cutting may be found after diligent search. The clear quartz pebbles called "Cape May diamonds" are found at the same locality. The majority of the pebbles have a poor color or are badly checked and flawed. The pebbles are composed of angular, close fitting, interlocking grains of quartz, which show some strain between crossed nicols under the microscope. The color pigment consists of very small amounts of iron oxide dust in some of the small cracks and interstices. Apricotine polishes well and the delicate colors combined with the translucency furnish an attractive and unique gem.

Creoline is an epidotized altered trap rock found in a ledge in the Brighton district of Boston, Mass., near the Roxbury "puddingstone" formation. The ledge is a mineralized fracture zone, in which the creoline occurs in pockets. A specimen examined under the microscope was composed of epidote grains with a pale to strong lemon yellow pleochroism, altered plagioclase, secondary quartz, probably some zeolite, pale-greenish actinolite needles and sheafs of fibers, and hematite dust or tiny grains. Calcite occurs in seams. Specimens of creoline exhibit a purplish-gray or brown-colored matrix with dark red spots inclosing yellowish-green epidote in spots and streaks with or without gray or white quartz and calcite. Mr. Deacon named the stone from the resemblance the colors bear to those of creole marble. Creoline receives a good polish, which displays its colors very prettily.

Verdolite is obtained from a vein in a quarry for building stone and road metal on the New Jersey side of Delaware River, near Phillipsburg. It is composed of rose-pink to white dolomite in granular and crystallized masses along with green talc in scales and fibrous masses. The latter occur in seams and patches in the dolomite. The translucent green talc in delicately rose-tinted and white dolomite make beautiful contrasts. The stone is too soft to receive a high polish and the talc generally wears out deeper than the dolomite in cutting. The name verdolite [a] was given by Wm. B. Reed, of Easton, Pa., to an ornamental stone quarried in that region. The material cut for gem purposes is very similar to the ornamental stone.

WABANITE.

Mr. Shelly W. Denton, of Wellesley, Mass., mentions the use of a purplish chocolate-colored rock with cream-colored mottlings in the arts and crafts jewelry. This material was found by Mr. Denton in the vicinity of Wellesley and has been called "wabanite," after a former noted Indian of that region. The quantity of wabanite obtained was limited. Specimens of the rough gem and a cut stone furnished for examination consisted of very fine-grained siliceous slate, which may have once been a rhyolite or similar volcanic rock. It is roughly banded with black and gray layers, which are in places much contorted and crinkled.

[a] Talc deposits of Phillipsburg, N. J., and Easton, Pa.: Ann. Rept. Geol. Survey New Jersey, 1904, pp. 172–173.

DOVE-COLORED CHERT.

Mr. William Kley, of Denver, Colo., very kindly sent in to the Survey a specimen of a new stone being cut for gem purposes. This material was found in New Mexico by F. H. Stanwood, of Colorado Springs. It is composed of dove-colored chert breccia, with a filling of lighter gray-colored fragments and cement. The stone polishes well, especially the larger fragments of dove-colored mineral, of which it is chiefly composed. As a scarf pin or similar jewelry this stone should look well; its charm lies in its simple color.

REALGAR.

Prof. C. G. Wheeler, of Chicago, reports the use of small quantities of realgar, arsenic sulphide, for jewelry. The material used comes from near Mineral, Lewis County, Wash., and is handled by the Mineral Creek Mining and Smelting Company, with offices at 300 Wabash Avenue, Chicago.

COLORED PORPHYRY.

Mr. A. L. Delkin, of Seattle, Wash., has kindly furnished samples of fine-grained quartz porphyry with bluish-green, greenish, and brown colorings from the River Range, Mohave County, Ariz. In some of the specimens the bluish-green and brown colors occur together in pretty contrast. This porphyry is fairly hard and receives a good polish. Some of it has been cut with attractive results. The porphyry contains small phenocrysts of glassy quartz. It probably represents a partly altered rock which has been hardened by silicification and colored by a small amount of pigment. A little white opal, occurring as float in the same region, has also been cut.

JASPER COPPER ORE.

The possibility of a new copper-ore gem or ornamental stone from the Humming Bird Mine, in Paris Canyon, near Montpelier, Idaho, has been suggested by H. S. Gale, of the United States Geological Survey. The specimen examined was obtained from the dump at the mine by Mr. Gale. The constituent minerals are quartz, with a very fine red dust pigment and malachite. Under the microscope the quartz is seen to be granular, with close fitting grains and is dusted full with minute red specks, probably hematite. The malachite is in bright green grains and masses with a radial fibrous and occasional spherulitic crystallization. The quartz incloses numerous small grains or buhrs of malachite bristling with needles. In the hand specimen the rock is bright jaspery red, with dark-green splotches throughout. The quartz is close-grained and tough, and takes a good polish. The malachite is softer, though sufficiently hard to be polished along with the quartz. The contrast between the two colors is pleasing and for use in small ornaments, as inkstands, paper weights, etc., the rock would serve well. It is also probable that it would be accepted as a gem for scarf pins, brooches, etc.

The specimen examined measured only a little over 2 inches square, and was associated with white quartz. It is not known from what part of the mine this material came, nor whether a plentiful supply could be obtained.

VARIOUS COPPER ORE GEMS.

Among the miscellaneous copper-ore gems may be placed the copper-stained silver ores from the desert regions of Nevada. These ores may be quartz or porphyry ores containing some or all of the following minerals: Blue azurite, green malachite, and bluish-green chryscolla stains in seams and fractures. In some cases ruby silver or other silver minerals are present, and hematite and other iron ores also occur. There are numerous localities where such material can be obtained. Good specimens have been seen from the mine of G. E. Wilson, 2 miles northwest of the deserted mining camp of Columbus, and from a mine owned by R. J. Jones, between Candelaria and the White Mountains in California.

MEXICO.

CARMAZUL AND CHRYSOCARMEN.

Of the oxidized copper ores recently used in jewelry is a variety from Lower California, Mexico, showing dark red and brown colors mottled with light and dark blue and small amounts of green. The variations in patterns, colors, and shades of colors are large, and along with the fair polish that the material receives, render it a pretty ornamental stone or gem. This copper-ore gem was named "Carmazul" by Oscar Wehrend, of Los Angeles, and is handled by the Whitley Jewelry Company, of Los Angeles, under that name. A material of very similar nature, both in coloring and composition, also obtained from Lower California, has been sold by E. Schaaf-Regelman in New York under the name of "Chrysocarmen."

Carmazul and chrysocarmen are composed of hematite, jasper, chalcedony, and quartz, through which chrysocolla and small amounts of fibrous malachite occur in masses, veinlets, and patches. The hematite and jasper appear to have been the original minerals and after fracturing were filled with the bright-colored copper ores.

CALAMINE.

The beautiful blue, gray, and green calamine obtained by Charles H. Beers, of the Ysabelita Mining Company, in Mexico, and described in this report for 1908 has been called "Chalchihuitl." This name has been chosen by Mr. Beers, since it is thought that the mineral answers the description of the mineral by that name so much esteemed by the Aztecs. Mr. Beers[a] states that this name has been pronounced acceptable by several mineralogists and experts on precious stones, as Max Bauer, Alfred Free, and C. N. Warren. Alfred Eppler,[b] of Crefeld, says this stone has been described by Bernal Diaz as the original chalchihuitl of the Aztecs. According to this description

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[a] Personal letter.
[b] Jewelers' Circ. Weekly, July 20, 1910, from Deutsche Goldschmiede Zeitung.

the mine worker in whose possession the first piece was found claimed to be a descendant of Montezuma and stated that the mineral was chalchihuitl. The name chalchihuitl has not been definitely given to any other modern gem, though George F. Kunz[a] has shown that several green minerals were thus called by some early writers. Among these minerals were turquoise, green quartz or prase, and jadeite. Doctor Kunz favors turquoise and jadeite as the two probable varieties of chalchihuitl of the Aztecs. The difficulty of placing this name on the proper mineral has probably arisen from the fact that greenish minerals were very pleasing to the Aztecs, who therefore used several varieties, calling each chalchihuitl. Whether calamine of gem quality is the chalchihuitl of the ancient Aztecs may never be proved, but, coming from Mexico, the home of the Aztecs, the name seems fairly well chosen.

Calamine is hydrous silicate of zinc found with other zinc minerals in the zone of oxidized ores. It commonly occurs in groups of crystals, stalactitic, mammillary, and botryoidal masses with a fibrous structure and drusy crystal surfaces. The mineral is heavy, the specific gravity ranging from 3.4 to 3.5. The hardness is about 4.5 to 5, so that the cut gems should not be treated roughly, lest they lose their polish. Calamine occurs in transparent to translucent masses ranging in color from colorless to white, gray, bluish, greenish, and sometimes yellowish. The variety called chalchihuitl ranges from delicate bluish to gray to greenish in color. Part of it has fibrous silky texture with radial structure. Often there is a delicate curved banding across the direction of the fibers. As mentioned by Mr. Beers, these markings give the effect of the rays of the rising sun. Chalchihuitl is translucent, and some specimens have an even texture and color, either blue or green. The latter stones resemble chrysoprase and the green smithsonite from Kelly, N. Mex. The stones are cut principally "en cabochon," and may be used in a variety of jewelry.

Mr. Beers believes he has found the mine from which the chalchihuitl was obtained in an "antiqua" or ancient working some 300 feet across and nearly 150 feet deep. It is hoped further search will reveal more gem material, especially of the bluish variety, as the supply of that is becoming scarce. During 1909 several thousand dollars worth of chalchihuitl gems were sold.

CINNABAR QUARTZ MATRIX.

According to Mr. A. L. Shelby, of the George Bell Company, of Denver, that company has been cutting a matrix stone composed of bright red cinnabar in milky quartz. This material is sufficiently hard to polish well and is very suitable for cuff buttons, pins, etc. Only a small quantity was obtained from Mexico, the exact locality not being learned.

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[a] Gems and precious stones of Mexico: Trans. Am. Inst. Min. Eng., vol. 32, 1902, pp. 55–93.

PRODUCTION.

There was a large increase in the value of the output of precious stones in the United States during 1909. Among the gems showing large increases are turquoise, variscite, tourmaline, and chrysoprase. These minerals, along with sapphire, californite, and kunzite are credited with large values in the table of production. Of the above gems all but sapphire showed an increase in value in 1909 over 1908. A number of precious stones, as beryl, garnet, peridot, and topaz, showed a large decrease in value. Many changes, both increases and decreases, are recorded among the minor and other gems.

As in former years it has been necessary to estimate the value of some of the minerals from the quantity of the production reported. In doing this it is the aim of the Survey to give the value of the rough material rather than that of the elaborated gem. It is not always possible to give values for the rough gem material, since the output reported is in many cases the quantity and value of selected material or manufactured products. Some producers fail to report their output of precious stones to the Survey. In other cases gem material is mined or purchased by persons not regularly in the trade and whose names are not on the Survey lists, so that no record is obtained of their production. Under such circumstances it will be understood that the table given below is not to be considered an accurate statement of the production of precious stones. It is rather an approximation from which a general idea of the status of the precious stones industry in the United States can be formed.

The statistics of production of precious stones in 1909 were collected in cooperation by the United States Geological Survey and the Bureau of the Census.

Production of precious stones in the United States in 1906, 1907, 1908, and 1909.

	Value.				Remarks.
	1906	1907	1908	1909	
Agates, chalcedony, etc., moonstones, etc., onyx.	$800	$650	$1,125	$750	About 1,000 pounds; California, Colorado, and Washington.
Amethyst	700	850	210	190	North Carolina, New Jersey, Colorado, and California.
Azurmalachite, malachite, etc.	....	250	5,450	2,000	Southwestern States.
Benitoite	....	1,500	3,638	500	Small quantity sold; California.
Beryl, aquamarine, blue, pink, etc.	9,000	6,435	7,485	1,660	52 pounds; California, Colorado, and Maine.
Californite	....	a 25,000	....	a 18,000	3,000 pounds; California.
Catlinite	....	25	....	....	No production reported.
Chiastolite	25	20	....	....	Do.
Chlorastrolite	....	....	25	2,400	Shores of Lake Superior in Michigan.
Chrysocolla	....	150	600	300	Southwestern States.
Chrysoprase	a 32,470	a 46,500	a 48,225	a 84,800	21,200 pounds; California and Arizona.
Cyanite	....	100	....	....	No production reported.
Diamond	....	a 2,800	a 2,100	2,033	About 460 specimens; Arkansas.
Diopside	5	....	120	....	No production reported.
Emerald	....	a 1,320	....	a 300	About a dozen crystals; North Carolina.
Epidote	....	60	....	15	15 pounds in pebbles; Colorado.
Feldspar, sunstone, amazon stone, etc.	100	1,110	2,850	a 2,700	8,000 pounds; Virginia and Colorado.
Garnet, hyacinth, pyrope, almandine, rhodolite.	3,000	6,460	13,100	1,650	76 pounds; mostly hyacinth; California.
Gold quartz	....	1,000	1,010	....	No production reported.
Jasper	....	675	....	100	200 pounds; California.
Opal	....	180	50	200	Nevada.
Peridot	2,400	1,300	1,300	300	Arizona.
Phenacite	250	25	95	50	Colorado.

a stimated.

Production of precious stones in the United States in 1906, 1907, 1908, and 1909—Cont'd.

	Value.				Remarks.
	1906	1907	1909	1910	
Petrified wood	150	325			No production reported.
Prase	50				Do.
Pyrite		400			Do.
Quartz, rock crystal, smoky quartz, rutilated, etc.	3,050	2,580	3,595	2,689	3,120 pounds; California, Colorado, and North Carolina.
Rose quartz	4,000	6,375	568	2,970	28,300 pounds; South Dakota and California.
Rhodocrosite		150			No production reported.
Rhodonite			1,250	125	California and New Jersey.
Ruby	600	2,000			No production reported.
Rutile		200		25	North Carolina.
Sapphire	39,100	a229,800	a 58,397	a 44,998	271,185 carats; Montana.
Smithsonite		800	a 1,200	300	New Mexico.
Spodumene, kunzite, hiddenite.	14,000	14,500	a 6,000	15,150	150 pounds kunzite; California.
Thompsonite			35	100	Michigan.
Topaz	1,550	2,300	4,435	512	36 pounds; Texas, California, and Colorado.
Tourmaline	a 72,500	a 84,120	a 90,000	a133,192	5,110 pounds; California, Maine, and Connecticut.
Turquoise and matrix	22,250	23,840	a147,950	a179,273	34,497 pounds; Nevada, New Mexico. Arizona, and Colorado.
Variscite, amatrice, utahlite	2,000	7,500	14,250	35,938	7,135 pounds; Utah and Nevada.
Miscellaneous gems				1,060	Apricotine, verdolite, creoline, datolite, natrolite, pectolite, apophyllite, iolite, chondrodite, etc.
Total	208,000	471,300	415,063	534,380	

a Estimated.

IMPORTS.

The importation of precious stones into the United States in 1909, as reported by the Bureau of Statistics, showed a large increase over that of 1908. The principal increases were in the imports of rough or uncut diamonds, diamonds cut but not set, and other precious stones not set. The increase in the importation of rough diamonds in 1909 amounted to over five times that of 1908 and indicates a return of the diamond cutting industry to nearly normal conditions. The importation of diamonds cut but not set was greater than in any previous year.

The following table shows the value of the diamonds and other precious stones imported into the United States from 1905 to 1909, inclusive:

Diamonds and other precious stones imported and entered for consumption in the United States, 1905-1909.

Year.	Diamonds.					Diamonds and other stones not set.	Pearls.	Total.
	Glaziers.	Dust or bort.	Rough or uncut.	Set.	Unset.			
1905	$6,851	$190,072	$10,281,111	$741	$20,375,304	$4,144,434	$1,847,006	$36,845,519
1906	104,407	150,872	11,676,529	305	25,268,917	3,995,865	2,405,581	43,602,476
1907	410,524	199,919	8,311,912		18,898,336	3,365,902	680,006	31,866,599
1908	650,713	180,222	1,636,798		9,270,225	a 1,051,747	910,699	13,700,404
1909	758,865	50,265	8,471,192		27,361,799	a 3,570,540	24,848	40,237,509

a Including agates. Agates in 1906, $20,130; in 1907, $22,644

GRAPHITE.

By Edson S. Bastin.

INTRODUCTION.

The natural-graphite industry of the United States, although of constantly growing importance, must be regarded, with a few notable exceptions, as in an experimental stage. The production is sporadic and of uneven grade, and, as a consequence, no steady markets have been built up. Artificial graphite exceeding the natural production in total value is manufactured in the electric furnaces at Niagara Falls, N. Y., but the combined production is only a fraction of what our industries demand. An amount commensurate with the total (natural and artificial) domestic production, but of a value ranging from two times as great in some years to six times as great in others. is imported mainly from Ceylon and Mexico.

The large amorphous graphite deposits of Sonora, Mexico, are operated by an American corporation, the United States Graphite Company, which treats the product at its factory at Saginaw, Mich.

Although most of the material of this report has not appeared before in print, some general information is republished herein with corrections and additions from the report on the production of graphite in 1908, which is now out of print.

The cause of the unstable condition of the graphite industry in this country is found in the facts that the largest domestic deposits are schists which carry small flakes of graphite disseminated through them and that the separation of the graphite from the accompanying minerals, especially mica, in such rocks is a problem of unusual difficulty. The one firm which can be said to have become firmly established in the treatment of such graphitic rocks, the Joseph Dixon Crucible Company, possesses an important advantage over other firms in that it manufactures much of its product into graphite paints, graphite grease, etc., before placing it upon the market. When the margin of profit is small, such control of markets becomes of vital importance. The following discussion of economic condition in the graphite industry, by Dr. Frederick D. Chester,[a] himself a graphite operator of long experience, is so true and instructive that it is quoted in full:

Various efforts have been made during the last ten or fifteen years to organize and maintain the flake-graphite industry in the United States, but merely

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[a] The flake graphite industry in the United States: Eng. and Min. Jour., vol. 88, 1909, pp. 785, 786.

as an industry for the production of graphite in its crude form independent of the manufacture of graphite products it has rarely been a success. To-day there are more abandoned mines and costly plants than those in operation, and the question might be asked, Why does this condition of things exist?

Every enterprise which has ever started has been founded on hope, and large sums of money have been ventured by promoters and organizers who have had very little true idea of commercial facts as applied to graphite and still less of the technical side of its milling operations. Thus, where mistakes have been made, it has frequently been at the start, due to errors of judgment, which in turn have been the result of inexperience. Experience is costly and mistakes must be made before it is gained, and where this cost has to be met by a host of stockholders, the latter are liable to lose confidence too soon, and often on the very eve of success.

It should be understood that the technology of graphite is as yet in a formative stage, and that there is no established system or scientific basis, such as applies to most of the mining industries, and for this reason operators are groping more or less in the dark. The industry is as yet too unimportant to attract the attention of the best experts in ore dressing, and it has been largely in the hands of local mechanics, who lack the proper scientific training and broad knowledge so necessary to the working out of a difficult problem. The difficulties are still further increased by the variable characteristics of the ores of different mines, making each problem in a measure a local one, so that while some mines which have had longer experience than others may have worked out a satisfactory system of milling for their own type of ore, this experience may be inapplicable to someone else. But what has been most lacking has been the absence of fundamental principles to form a basis of guidance, resulting in too much haphazard empiricism and too many costly undertakings which were fundamentally wrong.

Thus, while success is in a large measure dependent on the direction given the technical side of the industry, it is not altogether that, and the business side is equally important. It is largely a question of the difference between the cost of production and the market value of the product, and this balance is determined by a variety of conditions. If flake graphite were a staple product like copper, lead, or silver, produced by established methods and salable at all times in the open market at the fixed market price, the sales end would be simplified, but it is a manufactured product of variable quality and market value and is subject to laws of competition, which are also unusually severe because American flake has as yet to win a secure place in the market. Even if graphite could be considered as a raw material and could be sold on some uniform basis of price, as so much for each unit of carbon, the marketing of the product would be simplified, and it would be fairer both to the producer and the buyer. But no such system of determining values has ever had general application.

In general the cost of producing flake graphite is so high, and the price at which it is sold so low, that even under the most economic conditions the margin of profit is small. In many cases the cost of production has considerably exceeded the returns, and inevitable failure has eventually followed. Many ores are of too low a grade, or the expense of mining and milling them too high, to be profitable. Other ores are of such a character that the percentage of extraction under existing methods is unsatisfactory. These are weak points at the very start, which an experienced man should be able to see, before any money is spent on what is sure to be an unprofitable venture.

PHYSICAL AND CHEMICAL PROPERTIES.

Chemically, the purest graphite is carbon with a fraction of 1 per cent of ash and volatile matter. In the trade graphite is frequently referred to as plumbago, or black lead. The graphites of commerce contain various impurities, sometimes in large quantities. Graphites showing 90 to 95 per cent graphitic carbon are pure enough for the requirements of the general trade, and for many uses, such as paint making, graphites with as low as 30 to 35 per cent of graphitic carbon are employed. The mineral possesses certain physical characteristics which enable it to be easily recognized. These are its steel-gray to blue-black color, extreme softness (1 to 2 in the scale of hardness), a greasy feel, and the property of making a black metallic mark on paper. It is opaque in even the thinnest flakes, and the latter, though flexible, are inelastic. It is infusible, but it is volatile at high temperatures. The specific gravity in most cases lies between 2.20 and 2.27. The only mineral with which graphite might be confused is molybdenite, from which it differs slightly in color, the molybdenite having a somewhat bluish or greenish tinge. The two minerals may be distinguished by simple blowpipe tests. Graphite is in general a better conductor of electricity than are most of the amorphous forms of carbon. Tests by P. M. Lincoln, of the Niagara Falls Power Company, showed a resistance of 0.00032 ohm in a graphite electrode, while an amorphous carbon electrode of the same size showed a resistance of 0.00124 ohm. In the utilization of graphite the physical characteristics are frequently of the utmost importance. In the manufacture of graphite crucibles, for instance, a graphite of more or less fibrous character is desired. In the manufacture of pencils, on the other hand, a fine unctuous, amorphous graphite is required.

In the trade two varieties of graphite are generally recognized. The graphite that possesses a lamellar, scaly, flaky, or fibrous structure is classed as crystalline. The other forms of graphite, of whatever occurrence or appearance, are classed as amorphous. The two varieties are not sharply differentiated, and the distinction appears to be largely in the size of the graphite particles. Much of the so-called amorphous graphite mined in the United States is shale or slate containing a relatively small percentage of carbonaceous material. It is usually impossible without chemical tests to determine whether this finely divided carbon is graphite or amorphous carbon.

ORIGIN.

Graphite unquestionably originates in nature in different ways. The important deposits in the United States have probably been formed by the metamorphism of originally carbonaceous sediments. This metamorphism is in some places dynamic, resulting from earth movements (usually involving compression) which have affected the rocks over wide areas. In other places the metamorphism has been produced by the intrusion of igneous rocks. Some graphite deposits are the combined result of both dynamic and igneous metamorphism.

The deposits of disseminated crystalline graphite so abundant in the Adirondack region and in Pennsylvania are mostly schists in which graphite, rarely constituting more than 10 per cent of the rock by weight, is associated with quartz, feldspar, mica, calcite, garnet, and a few other minerals. In a few deposits graphite forms a constituent of impure crystalline limestone. These schists and crystalline limestones beyond reasonable doubt represent sediments which originally contained carbon, presumably of plant or animal origin. The sediments were changed to their present character by dynamic metamorphism, accompanied or followed in some cases by igneous metamorphism. The deposits of Alabama and North Carolina are probably of similar origin.

The amorphous graphite deposits of Sonora, Mexico; of Turret, Colo.; and of Colfax County, N. Mex., have been formed by the contact metamorphism of coal beds by intruded masses of igneous rocks.

The origin of the vein types of graphite deposits is not so well understood. It seems probable that some of them, such as certain of the Ticonderoga veins, were deposited from carbon-bearing solutions penetrating along fractures in the rocks during igneous metamorphism. Neighboring carbonaceous sedimentary rocks appear in most cases to have been the ultimate source of the graphite in such veins.

A graphite-bearing granite-pegmatite in Maine, described by G. O. Smith (see Bibliography, p. 29) contains graphite to the extent of 9 per cent, present mostly in evenly distributed flakes, with a few nests of pure graphite an inch in diameter. The graphite is disseminated in the larger masses of quartz and throughout the finer-grained matrix, although not within the larger crystals of feldspar. It appears, therefore, that the graphite crystallized possibly later than the feldspar, but plainly earlier than the quartz. Although the graphite in this instance crystallized with other minerals of an igneous rock, it has not been shown that it was not earlier absorbed by the pegmatite magma from bordering carbonaceous sediments.

Tests made by the writer on quartz associated with graphite from Lead Hill, near Ticonderoga, N. Y., appear to indicate that in nature graphite has been formed, at least in some deposits, at temperatures below 575° C., that is, at temperatures greatly below those at which it is produced artificially in the electric furnace (certainly over 2,000° C.). (See bibliography, under Origin of graphite.)

USES.

The characteristics possessed by graphite, and already mentioned, make it a mineral of great and increasing industrial importance.

The facts that graphite is nearly pure carbon, is relatively inert chemically, and volatilizes only at high temperatures make it of exceptional value in the manufacture of crucibles for the steel, brass, and bronze industries, etc. Most of the graphite used in the United States for these purposes is imported from Ceylon, the fibrous structure of the Ceylon product, not developed to a like degree in graphite from any other locality known, being of especial value in this utilization, since with clay it forms a stiffer "mix" than other varieties of graphite. Refractory muffles, stirring rods, dipping cups, skimmers, stoppers, nozzles, and other refractory products are made from material similar to that used in crucibles. Graphite is also used in making boxes for burning electric-light filaments. A mixture of graphite and crucible clay is used for lining ladles and for patching furnace linings. The poorer the binding quality of graphite used in the manufacture of crucibles and other refractory products requiring considerable tensile strength, the greater the quantity of other binding material which must be added to hold the mass together, thus increasing the more readily fusible constituents of the crucible at the expense of the more refractory and materially decreasing its life. It is for this reason that amorphous graphite has never been successfully applied in the manufacture of such products.

One of the most important uses of graphite is for lubricating. The addition of graphite to oil results in a lower frictional resistance than would be obtained by the use of oil alone. The quantity of oil required for a given service is also reduced and a lighter grade of oil or one of inferior quality may be employed without decreasing the quality of the lubrication. A small quantity of graphite only is required, and the benefits derived from its use persist long after the application has ceased. In light bearings of machinery where oil can not be used on account of the danger of soiling delicate textiles, graphite can be used alone as a lubricant. Both the amorphorous and the crystalline varieties of natural graphite are extensively employed for lubrication. The artificial graphite manufactured at Niagara Falls is also largely utilized in this way, and the Acheson Company has secured a product termed "deflocculated graphite," which it is claimed shows little or no tendency to sink when mixed with oil or water, and when suspended in water will pass through the finest filter paper made. The suspension is obtained by adding small quantities of gallotannic acid and other substances to the medium carrying the graphite. Some attempt has been made to utilize a mixture of graphite and water for lubricating purposes. Such a mixture, although perhaps less liable to produce rust than water alone, is not a rust preventive and is not so safe for steel bearings as a mixture of oil and graphite.

The use of graphite in the manufacture of pencils is probably both its oldest and its best known application. This industry in Germany and England is several centuries old, and many of the modern factories manufacture hundreds of varieties of pencils, yet the percentage of graphite used for this purpose is not large, being undoubtedly less than 10 per cent of the world's production, and one authority estimates it as low as 4 per cent. In this industry the physical character of the graphite is of great importance. Crystalline graphite, however pure, would, if used alone, yield a "lead" that would slip over the paper without leaving more than a faint streak. Furthermore, it is almost impossible to grind the easily cleavable flake graphite into a powder of the fineness and evenness of grain requisite for the better grades of pencils. The purer grades of amorphous graphite constitute the bulk of the material used in pencil manufacture. For some of the cheaper pencils only one kind of graphite is used, but the graphite for pencils of the better grades is a careful blend of several kinds. One blend, for example, contains about one-third Ceylon graphite, one-third Bohemian graphite, and one-third Mexican graphite. The Ceylon graphite adds to the smoothness of the "lead," the Bohemian graphite being added for its blackness. Graphite when used for pencils is mixed with carefully refined clay, which is usually imported from Germany; no domestic clay has yet been found entirely suitable for pencil manufacture. The more graphite and the less clay the softer the pencil; the less graphite and the more clay the harder the pencil. The cores of softer pencils are usually made larger than those of the harder ones in order to give them equal tensile strength. For a pencil of medium hardness (H B) about one-third clay is commonly used. The wet mixture of clay and graphite is worked and reworked until it is so pliable that it can be looped in coils and even tied in loose knots.

Up to a few years ago every American pencil manufacturer had to import his graphite from Bohemia or Bavaria. About ten years ago a large deposit of amorphous graphite was discovered in Sonora, Mexico. This proved to be of excellent quality for pencil making and many other uses, and the American pencil trade now derives its supply mainly from this source. Some Mexican graphite is also exported to European pencil manufacturers.

A use which has increased rapidly in importance within the last few years is the manufacture of graphite paint, especially for structural iron and steel works. Much of the graphite used for this purpose is rather impure, the specifications frequently requiring not more than 35 or 40 per cent of graphite in the paint pigment, the remainder being generally siliceous, aluminous, or ferruginous material. Six graphite paints used in tests on the Pennsylvania Railroad bridge at Havre de Grace, Md., showed from 19.16 to 97.80 per cent of graphite in the pigment. Recent tests made in cooperation between the Office of Public Roads of the Department of Agriculture and the Paint Manufacturers' Association, for the purpose of determining the relative merits of various paint pigments as preservative coatings for iron and steel, have yielded results of great importance, with which makers and users of graphite paint should be familiar. Reference to this report is given in the bibliography.

Large quantities of amorphous graphite and of finely-ground crystalline graphite are used for coating molds in foundries. A high degree of purity, though essential for the finest castings, is not necessary in all graphites used for this purpose; in fact, the presence of siliceous material may sometimes be of positive benefit by causing the graphite to cling or spread better on the face of the mold. The high electric conductivity of graphite renders it superior to amorphous carbon for certain electric purposes, such as the manufacture of electrodes for use in the electro-chemical industries. Considerable amounts both of amorphous graphite and of finely ground crystalline graphite are used in the manufacture of stove-polishing powders and pastes. Another use of crystalline graphite is as a protective polish for gunpowder and as a packing material for the delicate electric lamp filaments; it is also used in electrotyping and as a filler for dry batteries. An impure and cheap graphite, mined in Georgia, is used as a filler in fertilizers, to which it also imparts a dark color; but a still more unusual application has been its use to color and glaze both tea leaves and coffee beans, the pure graphite being a harmless material which protects these articles against moisture and adds to their attractive appearance.

ARTIFICIAL GRAPHITE.

The manufacture of artificial graphite on a commercial scale is conducted by the International Acheson Graphite Company, of Niagara Falls, which utilizes electric power generated at the falls. Mr. Acheson patented the process for the manufacture of graphite by the electric furnace in 1896, and its commercial development has been so rapid that at present the output of artificial graphite is slightly greater than the whole production of natural crystalline graphite in the United States. Pure amorphous carbon appears to be converted into graphite only very slowly in the electric furnace at atmospheric pressures. Pure petroleum coke, for example, yields practically no graphite when so heated, and the carbon cores of the furnace are converted into graphite only when impure. The conversion appears to take place on a commercial scale only when certain impurities, usually siliceous, aluminous, or ferruginous, are present. These need not form more than 3 per cent of the total, but to obtain the best results should be evenly disseminated through the mass. The explanation of the conversion which has been most generally accepted supposes that the amorphous carbon first unites with the siliceous, ferruginous, or other impurities present to form carbides, which are later decomposed with the formation of graphite and the volatilization of the other constituents. The small amount of impurity required to effect the change is explained by supposing that the transfer becomes progressive, vapors of iron or silicon traversing the entire charge, combining with molecules of amorphous carbon, and then abandoning them in a graphitic state. This explanation is not, however, accepted by all investigators. Anthracite coal carrying a small amount of finely distributed ash is used in the manufacture of the ordinary grades. An anthracite with 5.78 per cent ash has yielded a graphite with only 0.03 per cent of ash. For obtaining the purest grades of graphite petroleum coke is substituted for anthracite. An important part of the industry at Niagara Falls is the graphitization of rods and bars of amorphous nongraphitic carbon for use, mainly as electrodes in various electro-chemical industries. The rods and bars used are molded in the shape desired and suffer little change of form in the process of graphitization. After graphitization the pieces may be sawed or turned to any desired shape. The earlier productions of artificial graphite were not as soft and unctuous as much of the natural graphite, but in 1906 Mr. Acheson devised a process of manufacturing graphite of this type which has since been used in increasing quantities for lubricating purposes. The so-called "deflocculated graphite" is said to be produced by adding small quantities of gallotannic acid and ammonia to oil or water mixed with very fine graphite. The latter, it is claimed, will then remain in suspension almost indefinitely and can thus be fed through ordinary oil cups.

In spite of the development of the manufacture of artificial graphite by the electric furnace, the demand for the natural product has increased very largely in recent years because of the growth of the iron and steel industry, the largely increased use of copper and its alloys, the increased need for lubricants, and the development of electric machinery which calls for graphitized products.

PRODUCTION AND IMPORTS.

NATURAL GRAPHITE.

Production.—The great bulk of the production of crystalline graphite came, as in previous years, from New York, Pennsylvania, and Alabama; Alaska and Massachusetts produced small quantities. Among the producers of amorphous graphite, Georgia, with its low-grade product used for fertilizer filler, ranked first. The remainder of the amorphous product came from small mines scattered through the Middle and the Far West. The figures for the production of amorphous and crystalline graphite in 1909 are not directly comparable with those for previous years, because the Alaska and the Alabama products, which had previously been erroneously classed as amorphous, were in 1909 placed in the crystalline group. The low tonnage produced in 1908 was due to the suspension of operations by the Georgia producers of low-grade amorphous graphite for fertilizer filler. Although these firms resumed operation in 1909 the tonnage still did not reach the figure of 1905, 1906, or 1907. The value of the 1909 production, on the other hand, was higher than that recorded for any previous year. The increase is largely to be credited to the increased production reported by the Joseph Dixon Crucible Company from its mine at Graphite, N. Y., and to increased output in Alabama. As the statistics for 1909 were collected by the Bureau of the Census, no reports of market conditions were received.

In 1909 as in 1908 and 1907, New York ranked first both in quantity and value of the product. Alabama, which has usually ranked second, was in 1909 outranked by Pennsylvania.

In the following table are given the statistics of production of natural graphite in the United States, by States, in 1909:

Production and value of natural graphite in the United States, 1909, by States.

State.	Amorphous.		Crystalline.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Short tons.		*Pounds.*		*Short tons.*	
New York	....	....	2,498,400	$138,905	1,249	$138,905
Pennsylvania	....	....	2,098,000	116,466	1,049	116,466
Other States[a]	5,096	$32,238	1,698,000	57,900	5,945	90,138
Total	5,096	32,238	6,294,400	313,271	8,243	345,509

[a] Includes Alabama, Alaska, Colorado, Georgia, Massachusetts, Michigan, Nevada, Utah, and Wisconsin.

Production of natural graphite, 1905–1909.

Year.	Amorphous.		Crystalline.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Short tons.		*Pounds.*		*Short tons.*	
1905	21,953	$80,639	6,036,567	$237,572	24,971	$318,211
1906	16,853	102,175	5,887,982	238,064	19,797	340,239
1907	26,803	125,821	4,947,840	171,149	29,277	296,970
1908	1,443	75,250	2,288,000	132,840	2,587	208,090
1909	5,096	32,238	6,294,400	313,271	8,243	345,509

Imports.—The imports for consumption of graphite into the United States in 1909 came mainly from Ceylon and Mexico and showed a greater value than in any previous year. The total value of the imports for the year was more than twice the value of the domestic production (natural and artificial). The imports for the last five years are:

Imports for consumption of graphite into the United States, 1905–1909, in short tons.

Year.	Quantity.	Value.
1905	17,457	$983,034
1906	25,487	1,554,212
1907	22,939	1,777,389
1908	11,456	762,367
1909	21,267	1,854,459

ARTIFICIAL GRAPHITE.

As shown in the following table, the production of artificial graphite in 1909 was somewhat less than in 1908, though the price was higher. Both quantity and value are nearly the same as for 1907.

Production and value of artificial graphite, 1905–1909.

Year.	Quantity.	Value.	Price per pound.
	Pounds.		*Cents.*
1905	4,591,550	$313,980	6.83
1906	5,074,757	337,204	6.64
1907	6,590,000	481,239	7.30
1908	7,385,511	502,667	6.80
1909	6,664,017	480,000	7.20

WORLD'S PRODUCTION.

The world's production of graphite for the years 1906, 1907, and 1908, as gathered from various Government publications, is as follows:

World's production of graphite, 1906, 1907, and 1908, in short tons.

Country.	1906.		1907.		1908.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
United States	19,797	$340,239	29,277	$296,970	2,587	$208,090
Austria	42,016	293,615	53,013	387,930	48,970	349,118
Canada	446	18,780	579	16,000	251	5,555
Ceylon	40,320	3,406,550	36,406	2,889,596	28,916	2,593,160
France	276	2,433	138	1,206		
Germany	4,470	47,122	4,409	47,671	5,340	60,264
India	2,912	48,709	2,725	35,949	3,218	69,814
Italy	11,910	61,162	12,125	61,374	14,235	71,758
Japan	155	12,191	115	5,222	195	8,592
Mexico	4,315	77,110	3,530	54,339	1,742	28,426
Norway	2,101	5,884	1,543	14,974	1,192	13,005
Sweden	41	1,197	36	946	73	2,046
Queensland	34	973	34	965	22	292
Total	128,793	4,315,965	143,930	3,797,142	106,741	3,410,120

INDUSTRY BY STATES AND TERRITORIES.

ALABAMA.

The only producers in Alabama were the Allen Graphite Company and the Ashland Graphite Company, both operating in Clay County. The latter is the successor to the Entiachopes Graphite Company and began operation on July 1, 1909. In all the Alabama deposits the graphite is disseminated in small flakes, which form but a small percentage of the total weight of the rock.

The Alabama production in 1909 was notably in excess, in tonnage and in value, of that for 1908, but only slightly in excess of that for 1907. Formerly erroneously tabulated as amorphous, it was in the 1909 tables transferred to the crystalline class.

ALASKA.

Extensive graphite deposits occur in Alaska on both the northern and the southern slopes of the Kigluaik Mountains in the southern part of Seward Peninsula. On the south side of the range between Grand Central and Windy creeks [a] a sharp ridge is made up of biotite schists striking east and west intruded by dikes and sills of granite and pegmatite. Some of the schists are highly graphitic, the graphite occurring as abundant small flakes, much of it not distinguishable on casual examination from biotite. Locally graphite is segregated in beds of much flattened lenticular form lying in the cleavage of the schist and reaching thicknesses of 6, 8, or even 18 inches. Thin beds of schist with numerous large garnets are included, and quartz is nearly everywhere present.

The sills and dikes of pegmatite which cut the graphitic schists also contain graphite. The graphite in these appears to have crystallized at the same time as the other pegmatite minerals. At one place about 8 inches of solid graphite is included between a pegmatite sill and the overlying schist. The steep slopes of the mountains are strewn with loose fragments. One block approximately 7 feet by 6 feet by 30 inches consisted of about equal amounts of schist and apparently almost pure graphite. These deposits are on the south side of the range and have not been developed.

On the north side of the Kigluaik Mountains [b] deposits of graphite occur, upon which some development work has been done. One firm—the Alaska Graphite Company, of San Francisco—has shipped considerable quantities from this locality to the United States. At this place graphitic schists are interlaminated with more quartzose biotite schists. Both are intruded by granitic rocks. Much of the graphite is obtained in "blocks" 2 feet in length and 1 foot in thickness, practically unmixed with foreign material. Dislocations and fractures make the stoping out of the ore more or less dangerous. After the ore is broken from the ledge it is cobbed and hand sorted. In this sorting less than 25 per cent of the material is retained. This

[a] Moffit, Fred. H., The Nome region: Bull. U. S. Geol. Survey No. 314, 1907, pp. 139–140.

[b] Smith, Philip S., Investigations of the mineral deposits in Seward Peninsula: Bull. U. S. Geol. Survey No. 345, 1908, p. 250; also, Recent developments in southern Seward Peninsula: Bull. U. S. Geol. Survey No. 379, 1909, pp. 300–301.

is sacked and hauled down the steep slope of the mountains on sleds to the flats surrounding Imuruk Basin. The sacks are then transported by horses to the shore, where they are put aboard a boat and taken to Teller for shipment. The Alaska Graphite Company continued development work during 1909. The small quantity imported was ground in San Francisco and sold principally for foundry facings. All of the material shipped was crystalline so far as known. It is said to average from 50 to 75 per cent graphite.

COLORADO.

Amorphous graphite is mined in Colorado by the Federal Graphite Company about 2 miles northeast of Turret in Chaffee County. The mine is situated on the west slope of Graphite Hill, within about a mile of the stage road from Salida to Turret (14 miles), and was visited by the writer in the summer of 1909.

The present workings consist of two inclined shafts located about 100 feet apart on the same lode. The incline shafts have been sunk to a depth of 40 to 50 feet and some drifting and stoping has been done. A tunnel is being driven about 125 feet below the mouths of the inclines, from which a raise will be made to the graphite bed. The working is done by hand drilling.

The graphite occurs in one principal and a number of subordinate beds interbedded with white to gray crystalline limestone, buff-colored quartzite, and dark-gray to purplish quartzitic schist. The sediments and associated graphite beds strike about north and south and dip to the east at from 30° to 40°.

The hill slope above the graphite beds is occupied by a gray to purplish quartz-schist, but just over the crest of the hill and not more than 500 or 600 feet east of the graphite a large area of gneissic biotite granite is reached. Fine-grained granite occurs as a dike cutting the sediments within a few feet of the main graphite bed at the mouth of both of the inclines, and a tongue of graphite granite a few inches wide was observed penetrating slightly graphitic material just beneath the productive graphite bed.

The main productive bed as now exposed varies from 3 to 4 feet in thickness, somewhat more than half of this thickness consisting of the second grade of ore, which is lower in graphite than the first grade, higher in clayey material, and of a grayish or purplish tint. The first grade of graphite is dull black and very pure, the purest portions showing a somewhat foliated structure. Both grades are very fine grained and earthy and are properly classed in the so-called amorphous group. In the northern incline a second bed 1 foot thick of first-grade ore was exposed about 4 feet above the main bed. What appears to be the same graphite bed has been prospected north and south along the slope of Graphite Hill for about a mile. In the southern incline graphitic beds are separated by a bed of crystalline limestone, tapering from a thickness of 2½ feet to 8 inches in a distance of about 20 feet.

It is evident that this graphite was originally coal and highly carbonaceous shale interbedded with sedimentary rocks. The coal has been converted into graphite and its inclosing sandstones and limestones into quartzite, quartzitic schists, and crystalline limestones through the heating and other contact metamorphic effects of large masses of granite which have been intruded into the sediments. The granite and granite gneiss occupies most of the country between this mine and Turret and forms large areas south and east of the mine.

The first-grade graphite is packed in bags; the second grade is shipped in bulk. It is hauled 5 miles, mostly downhill, to a siding on the Denver and Rio Grande Railroad and shipped to the mill of the company at Warren, Ohio. Here it undergoes fine grinding and is sold for use as paint pigment, in stove polishes, for lubricants, foundry facings, etc. Some of the best grade has been used in the manufacture of lead pencils.

MICHIGAN.

Graphitic rock is obtained from Baraga County, in northern Michigan, by the Detroit Graphite Company, and shipped by rail to its mill at Detroit. The mine is located 7 miles south of L'Anse, a station on the Duluth, South Shore and Atlantic Railway. The mine is worked intermittently, most of the rock being hauled to the railroad in the winter time over the snow.

The rock mined is a dark reddish-brown graphitic and ferruginous slate which is said to average about 33 to 35 per cent of graphitic carbon. The latter is so finely divided that it should be classed as amorphous. An analysis of this rock, made by Prof. A. B. Prescott, of the University of Michigan, and furnished to the writer by the company, is as folllows:

Analysis of graphitic rock from Baraga County, Mich.

Carbon, graphitic (C)	28.39
Silica (SiO_2)	46.97
Aluminum (Al_2O_3)	16.90
Iron, soluble, as Fe_2O_3	.41
Iron, insoluble, as Fe_2O_3	3.81
Calcium (CaO)	.47
Magnesium (MgO)	.52
Water, uncombined (H_2O)	.13
	97.60
Carbon dioxide, combined water, sodium compounds, loss, and undetermined matter	2.40
	100.00

The rock is too fine grained to permit of any concentration of the graphite and is ground just as it comes from the mine and used only as a paint pigment, for which it appears to be well adapted. The lumps of rock are first reduced in a jaw crusher, then dried and pulverized in a continuous feed tube mill. Finally it is air floated, so that an exceedingly fine-grained powder is obtained. The black pigment thus obtained is used not only in the manufacture of black paints, but is mixed with other pigments to yield gray, dark-green, and dark-red paints. A large reserve having accumulated, no mining was done during 1909.

Messrs. Cobb, Gingras, and Tuttle have acquired a graphite property 8 miles south of L'Anse. No mining has yet been done and the L'Anse mill was not to be completed before the summer of 1910.

At Saginaw, Mich., is located the large factory of the United States Graphite Company, where the amorphous graphite mined in Sonora, Mexico, is treated. The process consists simply in grinding in continuous feed tube mills followed by air flotation. Some of the graphite is further mixed with greases for lubricating purposes, and with other pigments and oil for black, dark-green, and dark-brown paints.

NEW JERSEY.

The following data regarding the property of the Raritan Graphite Company, of High Bridge, N. J., was furnished by Henry B. Kümmel, state geologist, under date of August 31, 1908:

> The plant consists of a 2-story building with machinery, including two 80-horsepower boilers, two 65-horsepower Atlas engines, one 4-drill air compressor, 1 small hoist, and about 7 dump cars. The graphite-bearing rock forms a bed 30 to 50 feet wide, dipping 70° to the west with a north-northwest strike. It is covered by 6 feet of soil and disintegrated rock. The graphitic bed is considerably decomposed to a depth of 30 feet. The plant was erected in 1906 and up to the middle of November, 1907, they had worked intermittently about seven months. A tunnel was driven into the hill along the strike of the graphite-bearing rock for a distance of about 400 feet, and a pit sunk on top of the hill to a depth of 40 feet to the tunnel. The only ore treated was taken out in driving the tunnel, which was driven in the best part of the bed. The rock is supposed to contain from 4 to 8 per cent of graphite, and the mill test was said to have given about 4 per cent extraction. It is reported that during the seven months of work, 3½ carloads (25 to 30 ton cars) of rock were mined and shipped. The plant is still idle.

The geological occurrence of graphite in this district has been more fully described by Bailey and Stewart.[a] According to these writers the graphite occurs in several ways—(1) As a component of Franklin limestone; (2) in gneisses, which may be in part altered sediments, but in places are certainly mashed pegmatites; (3) in coarse granite dikes and pegmatites; and (4) in fine-grained quartzitic micaceous schists, especially where they are associated with pegmatites. The last-named mode of occurrence is the most important. Concentrating works at Bloomingdale, at High Bridge, and near Brookside have all failed. In the graphitic schists at Tuxedo Park the graphite plates are usually in parallel intergrowth with biotite plates. The graphitic schist is believed to be the product of the metamorphism of a sediment rich in organic matter. The pegmatites are graphitic only close to the schist or where they carry fragments of this rock.

No graphite was produced in New Jersey in 1909.

NEW YORK.

The Adirondack region has for some time been the leading and most regularly producing district in the country, largely because of the steady production of one mine at "Graphite," operated by Dixon's American Graphite Company. Many other properties which have thus far produced little are of very considerable scientific interest and some are of economic promise. Nearly all of the New York deposits that have been worked are located in the eastern and southeastern Adirondack region, in Essex, Warren, and Saratoga counties

[a] Bayley, W. S., and Stewart, C. A., Note on the occurrence of graphite schist in Tuxedo Park, N. Y.: Econ. Geology, vol. 3, 1908, pp. 535–538.

and the northern part of Washington County. West of the Adirondacks some prospecting and development work has been done in St. Lawrence County. All of the deposits are located within the area of pre-Cambrian metamorphic rocks. The deposits of Essex, Warren, and Saratoga counties were described by the writer in 1908. (See Bibliography.) Those in Washington County were visited in 1909 and are described in this report.

The graphite production of the State in 1909 showed a notable increase over that for 1908, but still fell somewhat below that for 1907. The increase was due mainly to the larger output of the Dixon's American Graphite Company, which continued to be the leading producer. The Dixon and the adjoining Faxon mines were described by the writer in 1908.[a] The following additional information in regard to the Faxon mine is quoted from D. H. Newland.[b]

> Adjoining the American mine on the southwest, the property of W. H. Faxon, of Chester, N. Y., has been explored recently with promising results. The same series of quartzites, limestones, and gneisses are in evidence, though the graphite deposits appear to occupy a higher position than those of the American (Dixon's) mine. That they are not a direct continuation of the latter is apparent from a field examination and is further indicated by slight differences in their character. There are two beds of graphitic quartzite separated by garnetiferous gneiss. The upper or main bed measures from 6 to 14 feet thick, and the lower one about 4 or 5 feet. They are cut off at the southwest end by a diabase dike, near which they are also slightly thrown by a transverse fault. The beds have been exposed along the outcrop by test pits and explored on the dip by drilling so as to prove their persistence over a large area. The average rock is fairly uniform in graphite which is of somewhat finer flake than that obtained from the American mine. It is planned to make mill tests during the current season; if they are favorable the construction of a large plant and the active exploitation of the deposits may be anticipated.

The Glens Falls Graphite Company, with mine at Conklingsville, Saratoga County, which operated in 1908, was idle in 1909.

The Empire Graphite Company, located near Porters Corners in Saratoga County, operated for ninety days during the year and produced some refined flake graphite.

The Crown Point Graphite Company continued to operate its mine and reported an important production.

A small production was reported by the Rowland Graphite Company, from a mine near Johnsburg in Warren County.

In October, 1909, the writer paid a very brief visit to the idle graphite properties situated in the town of Dresden, Washington County. They lie northwest of South Bay, an arm of Lake Champlain. The mine and mill of the Champlain Graphite Company are within a few rods of the shore of the bay near a prominent bluff known as the "Diameter." The mine and mill of the Adirondack Graphite Company are also located near the bay about 1 mile farther northeast. The properties may be reached by team and ferry from Whitehall (4–5 miles) or by boat from Whitehall (5–6 miles). The third mine, that of the Silver Leaf Graphite Company, is little more than a prospect pit and is situated in the woods about 1 mile northwest of the Champlain Graphite Company's plant. All three mines were opened about 1904.

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[a] Mineral Resources U. S. for 1908, U. S. Geol. Survey, 1909, pp. 723–725.

[b] Newland, D. H., The mining and quarry industry of New York State, 1909: Bull. New York State Mus. No. 142, 1910, pp. 37–38.

The mine of the Champlain Graphite Company is an open pit about 100 feet in length, and 25 feet in maximum depth, on a steep eastern hillslope. The rock is a quartz schist of rather variable character and not very regular foliation. The general strike is about N. 10° E. Some of the more massive layers which are dark gray and fine grained are seen under the microscope to be a granular association of greenish-brown hornblende, feldspar (labradorite) and magnetite, with a little biotite and quartz, but no graphite. They may represent dikes of diabasic rock which have later been metamorphosed to hornblende diorite. The rock in which these dioritic layers occur is schistose and graphitic. Some phases are finely and others coarsely foliated. A specimen typical of most of the material which has been milled when examined under the microscope was found to consist of quartz, muscovite aggregates, which probably represent decomposed feldspars, somewhat altered biotite, and graphite. The latter occurs in flakes which in thin section examination varied from 0.015 millimeter to 0.25 millimeter in thickness and up to 1.3 millimeter in length, The average length does not exceed 0.75 millimeter. The graphite is usually closely associated with the biotite, the two being interleaved in some places, as at the Bly mine in Ticonderoga.[a] The schist contains small isolated lenticles up to 2 inches wide of coarsely crystalline calcite, feldspar, quartz, and some garnet.

The mill at this mine had not been running for some time and the milling process could not be studied in detail. The equipment includes a jaw crusher, 12-inch rolls, broken-screw agitators, 3 buddles, drying floor, bolting machines, tube mill, etc.

A prospect opened by the Silver Leaf Graphite Company is situated in the woods about 1 mile west of the Champlain Company's mine. It consists of one pit 15 feet wide, 40 feet long, and 5 or 6 feet deep. The ore is similar to that at the Champlain Company's mine. The graphitic schists strike N. 10° W. and dip 25° E. More quartzose layers alternate with others which are more argillaceous and more graphitic. The company has no mill.

The mine and mill of the Adirondack Graphite Company are about a mile northeast of the Champlain Graphite Company's plant, near the wagon road which skirts the South Bay shore. The hillside quarry is about 100 by 100 feet and 30 feet in maximum depth, and all the rock exposed is more or less graphitic. The ore is a dark-gray, readily cleavable schist, which is much more uniform in character than that at the Champlain mine. The strike is quite regular and averages about N. 80° W. The dip is about 30° S. A thickness of 25 feet of graphitic schist is exposed. A thin section of typical ore when examined under the microscope shows quartz as the most abundant mineral with sharply bounded muscovite aggregates, which probably represent altered feldspar grains and abundant brown biotite. Associated with the last and for the most part interleaved with it occurs the graphite, which according to an analysis made in the laboratory of the United States Geological Survey,[b] constitutes 5.29 per cent of the rock. The sample analyzed was a composite one collected by the writer from various parts of the quarry and probably approaches

[a] Graphite: Mineral Resources, U. S., for 1908, U. S. Geol. Survey, 1909, p. 727.
[b] George Steiger, analyst.

closely the average run of the mine. Some chlorite and zoisite occur, and certain bands parallel to the schistosity are very rich in pyrite. The rock owes its foliated structure to subparallel arrangement of the graphite and the biotite flakes. The graphite flakes in the thin section studied vary from 0.02 millimeter to 0.15 millimeter wide and range up to 0.9 millimeter in length. The average length is not over 0.5 millimeter.

The mill of this company was situated at the quarry, but at the time of the writer's visit had not been running for many years. The equipment includes a jaw crusher, crushing rolls, a stamp-mill with two batteries of 5 stamps each, an inclined screw washer, Wilfley table, 2 buddles, and a flotation separator of special design.

PENNSYLVANIA.

CONDITION OF INDUSTRY.

The graphite properties which have been developed are all situated in the southeastern part of the State in Chester and Berks counties. Most of them lie near the Pickering Valley branch of the Philadelphia and Reading Railway, which runs from Phoenixville to Byers, a distance of 11 miles. All belong to the type of crystalline disseminated deposits.

The condition of the industry in Pennsylvania in 1909 may be summarized as follows:

The Acme Graphite Company, which took over the property of the Continental Graphite Company near Byers station, in Chester County, continued development work in 1909, but reported no production during the year. The American Flake Graphite Company's mine and mill, 2 miles from Kimberton station in Chester County, which were opened in 1908, were in active operation in 1909 and reported the largest production in the district. The Chester Graphite Company, near Chester Springs, and the Pennsylvania Graphite Company, near Byers, also reported important productions. Small sales of graphite were made by the Crucible Flake Graphite Company and the Federal Carbon Company, near Chester Springs, and by the Girard Graphite Company, near Kimberton. The Sterling Graphite Company, near Chester Springs, did some mining and milling during 1909, but none of the product was marketed. The Imperial Graphite Company continued development work during the year on its mine on French Creek, 12 miles from Byers, in the town of Coventry, and some of the output was refined in the mill of the defunct United States Graphite Company, at Byers. No sales were reported.

All the properties of present importance were visited by the writer in 1909, and are briefly described below.

CHESTER COUNTY.

Uwchland or Byers group of graphite mines.—A group of three graphite mines situated along the same belt of graphite-bearing rocks near Byers station (Uwchland postoffice), in Chester County, are similar in the character of the material mined.

The mine and the mill of the Acme Graphite Manufacturing Company are about three-quarters of a mile west-southwest of Byers station. This mine was operated in 1907 by the Continental Graphite Company. The present company (October, 1909) is rebuilding and enlarging the mill and conducting underground exploratory work. The graphite-bearing rocks strike nearly east and west (N. 85° E.) and dip about 45° S. They have been developed by an inclined shaft descending along the dip of the graphitic beds (45° S.). From the bottom of this shaft drifts have been driven eastward for about 150 feet and westward about 20 feet along the graphitic beds. An older level, now in part abandoned, is cut by the shaft at about 70 feet below the surface. A part of this drift is now caved, but it is open for about 70 feet east and 30 feet west of the shaft. The mill is close to the mine, but the processes of concentration which it is intended to use are kept secret.

The mine and the mill of the Pennsylvania Graphite Company are located about one-quarter of a mile south of Byers station. They were in active operation during 1909. The workings are mainly underground, but some ore is "milled" down from open pits into cars in the drifts and thence hauled to the shaft for hoisting. The shaft house and mill are under one roof. The underground workings now accessible aggregate over 900 feet in length to the east of the shaft; to the west of the shaft the drifts are said to extend for about 800 feet, but because of caving only 300 feet are now accessible. Considerable stoping has been done above this level. Drifts driven many years ago at higher levels aggregate several hundred feet more, but for the most part are inaccessible. The graphitic beds have a general east and west strike, and dip about 35° S. The shaft descends along the dip to the 70-foot level and from there descends vertically to a depth of 154 feet. There are several open pits. The largest one, temporarily abandoned, is about 30 feet in maximum depth, 100 to 150 feet in width, and about 400 feet in length along the strike of the deposit. The main open pit now being worked is 25 feet in maximum depth, 100 feet in width, and 150 feet in length along the strike of the deposit. The width of the underground excavations though variable is usually about 15 feet. The mill of the Pennsylvania Graphite Company has up to the present time handled only the softer types of graphitic rock available in this mine, the harder material being held in reserve pending the installation of new equipment. The mill is complicated in the arrangement of the machinery, though the types of machinery used are not very numerous. The concentration is accomplished by broken-screw log-washers and wet reels of various mesh. After passing through a rotary drier the concentrate is finished by repeated grinding in burrstone mills and screening, progressively finer screens being used after each grinding. The coarsest flake for crucible stock requires grinding on three stones; the finest material passes over six or seven stones.

The Phoenix Graphite mine, controlled by Pettinos Brothers, is situated about one-quarter of a mile east of the Pennsylvania Graphite Company's plant on the same general belt of graphitic rock. The mine has not been operated for many years, but the mill is in good condition and there is at present some talk of reopening. The underground workings were not accessible at the time of the writer's visit

(October, 1909). The shaft is said to be 98 feet deep and to connect with drifts aggregating several hundred feet in length. Graphitic rock has also been taken from several open pits, the largest of which is 25 feet in maximum depth, 100 to 150 feet in width, and 200 feet in length, parallel to the strike of the graphitic beds. Because of weathering and caving there are no good exposures of the graphitic rocks. The mill is located at the mine and includes a number of machines of special design for separation by flotation. The details of the process are secret. Several machines of improved pattern are now being constructed.

As already stated, all three of these mines are located on the same low east-west ridge and evidently on the same belt of graphitic rock. The graphitic rocks at the Acme and the Pennsylvania mines are similar, and those at the Phoenix mine, though not now exposed, probably belong to the same types. The freshest specimen of graphitic rock obtained was from the dump at the Pennsylvania mine. It is a gray, coarse, crystalline limestone containing graphite flakes oriented in every direction and ranging up to one-quarter of an inch in diameter, and plates of brown mica (biotite) up to one-eighth of an inch across. Rock of this freshness is rare, however, and a much commoner graphitic rock at both mines shows graphite flakes embedded in a dull white to greenish matrix which effervesces feebly or not at all with dilute hydrochloric acid (HCl). Under the microscope the whitish matrix in which the graphite flakes lie is found to consist of a finely granular aggregate of quartz and calcite (or dolomite) with some zoisite and epidote. Another type shows a more coarsely crystalline matrix consisting mainly of calcite with abundant chlorite (penninite) and an occasional crystal of tremolite and epidote. Most of the so-called "hard ore" at the Pennsylvania mine belongs to one of the types described above, characterized by a white rather highly calcareous matrix inclosing the graphite flakes.

At both the Pennsylvania and the Acme mines much of the graphitic rock is characterized by a dark, greenish matrix. This type usually can be excavated by pick and shovel without drilling and is thus termed "soft ore." A specimen of this ore contained graphite flakes in a matrix which the microscope showed to be almost exclusively epidote. Much of the decomposed rock exposed in the open pits is a rather fine-grained quartz-feldspar-graphite schist carrying a little muscovite. The schists at all three mines show a fairly regular east and west trend and dip to the south at 35° to 45°. Interbanded nongraphitic talc schists are exposed in the upper level of the Acme mine, where they form the wall rock at several points, and occur as lenses in the graphitic portions.

The other abundant rocks at this group of mines are granitic, mostly fine-grained granite-pegmatite. At one of the open pits these rocks make up about one-half of the total exposures. They are distinctly intrusive in the graphitic rocks and vary in size from very narrow stringers to masses many yards across. The intrusions for the most part parallel the trend of the graphitic rocks, though frequently breaking across. The granitic rocks contain graphite only in the immediate vicinity of the highly graphitic schists and limestones. Even near such contacts there are only occasional flakes.

The excavations at the Pennsylvania mine show beyond question the presence of at least three adjacent belts of workable graphitic rock. These are in general parallel in trend, but mining experience has shown that they are frequently cut off or displaced by irregular intrusions of pegmatite and by numerous fault planes, some of the latter being nearly parallel to the trend of the graphitic beds and others nearly at right angles to them. The soft character of much of the graphitic rock is due to the disintegrating action of surface waters, and it is to be expected that at greater depths the rocks will become firmer. The amount of graphitic rock available, even of the soft types, is unquestionably large.

A graphite mine is worked by the Imperial Graphite Company in the town of Coventry, 12 miles from Byers station, but the output has been small and the property was not visited by the writer.

Anselma graphite mine.—A graphite mine and mill which have been abandoned for many years are located about 1 mile southeast of Anselma station. The workings are mainly underground and are now filled with water. Where the graphitic rock outcrops it is a coarse-grained quartz-graphite schist showing graphite flakes up to half an inch across. The strike is N. 85° E. and the dip 40°. This trend, if continued westward, would connect this deposit with those at Byers, which exhibited similar strikes and dips, and it is possible that they lie in the same belt of graphitic rock. The mill located at the mouth of the shaft has been in part dismantled.

Sterling Graphite Company.—The mine and mill of this company are located about 1 mile northwest of Chester Springs station. The property was opened in 1904 and has been operated intermittently since then. The mine is an open pit, about 100 by 100 feet and 25 feet in maximum depth, and is located on a northeast hill slope. The rock as here exposed is dark-gray schist, striking north and south and dipping 35° E. Its character is quite uniform throughout its exposed thickness of 18 to 20 feet, if we except the presence of a few stringers of granite-pegmatite. Some of the latter carry an occasional graphite flake up to one-fourth of an inch across. Under the microscope the texture is found to be granular. Quartz is the principal mineral, with abundant altered feldspar (unstriated and probably orthoclase), biotite, and graphite. The biotite and graphite flakes are frequently attached to one another in parallel growth. The graphite flakes average about 0.6 millimeter in greatest dimension, though some reach 1.5 millimeters. The mine differs from all others in the district in the relatively hard and little weathered condition of most of the rock utilized. Only about 4 feet of weathered material occurs at the surface. In physical character the rock utilized is much like that mined by the Dixons at Graphite, N. Y.

The mill of this company is near the mine and is connected with it by a tramway. The schist is first crushed in a jaw crusher, then passed to a rotary drier, crushing rolls, pneumatic sizing machines, and flotation separators. The concentrates from these separators pass to a rotary drier and are finished in burrstone mills and classifiers. The capacity of the mill is 1,200 to 1,500 pounds of finished product in ten hours, and the weight of the finished product is stated to be about 3 per cent of that of the rock as mined, about 35 tons of the rock yielding 1 ton of finished graphite. The percentage of graphite in the finished product varies from 42 per cent in the lower grades of dust to over 96 per cent in the high-grade crucible stock.

Crucible Flake Graphite Company.—The mine and the mill of this company are located about 1 mile northwest of Chester Springs station. The plant was not in operation at the time of the writer's visit (October, 1909). The mine is located at the summit of a small knoll only a few hundred yards from the mine of the Sterling Graphite Company. It is a single open pit, about 100 feet by 100 feet and 20 feet in maximum depth. The graphitic rock is a part of the same body worked at the Sterling mine and is of essentially the same character. A tramway, traversing a tunnel for part of its length, connects the mine with the mill. The types of machinery used are similar to those at the Sterling mill, though differently arranged. The power of the large Corliss engine is first used to drive a dynamo, and the electric power is then distributed to motors connected with the different parts of the milling machinery. This arrangement has certain advantages in permitting greater freedom in the arrangement of the machinery and in permitting the suspension of certain parts of the milling process while others are still going on.

Chester Graphite Company.—The mine and the mill of this company are located about 1 mile southeast of Chester Springs station, and were in active operation at the time of the writer's visit (October, 1909). The graphitic rock is excavated from open pits and dumped down chutes leading to a tunnel about 400 feet in length. From the chutes it is drawn into cars and trammed to the mill. One of the open pits is about 300 feet long from east to west, 100 to 200 feet wide, and 50 feet in maximum depth; another is 100 feet along the strike of the rocks, 60 feet wide, and 50 feet deep.

The rocks exposed in the pits and tunnel are much weathered and in most of the excavating only picks and shovels need be used. The commonest rocks are quartz-feldspar-graphite schists of medium coarseness, in part quite free from mica, but locally carrying it (muscovite variety) in abundance. Their general strike is about N. 25° E. with a dip of 35° SE. These schists have been extensively intruded by granitic rock (granite-pegmatite), the injection locally being on such a small scale that the whole rock becomes a typical injection gneiss. Many of the smaller granitic stringers carry some graphite.

The flow sheet for the mill of this company has been published with explanatory descriptions in Mines and Minerals.[a]

Federal Carbon Company.—The mine of the Federal Carbon Company is located about half a mile northeast of that of the Chester Graphite Company. It has been idle for several years. The development includes both an open pit and underground workings. The open pit averages about 100 feet wide, with a maximum depth of about 30 feet; its length in a N. 50° E. direction parallel to the general trend of the graphitic schists is several hundred feet. From the open pit the graphitic rock, which is very soft, is "milled" down into the underground workings. The latter lie beneath the open pits in the same belt of graphitic rock, and the drifts, being for the most part parallel to the trend of the schists, are also parallel to the length of the open pit. The underground workings consist of a vertical shaft 143 feet deep, connecting with three levels at vertical depths, respec-

[a] Graphite: Mines and Minerals, vol. 30, 1910, pp. 394–395.

tively, of 55, 80, and 143 feet. The tunnel of the upper or 55-foot level extends northeast for 500 or 600 feet from the shaft, with a tunnel entrance close to the mill. The graphitic rock of the open pit has been "milled" down into this tunnel, and the rock hoisted from the 80-foot and the 143-foot levels has also been transported to the mill via this level. The drifts on the 80-foot level aggregate about 500 feet in length. The mine below the 80-foot level was filled with water at the time of the writer's visit. The drifts on the 143-foot level are said to aggregate about 700 feet in length. Very little stoping has been done from the 80-foot to the 143-foot level, but the drifts are in graphitic rock for nearly all of their length.

The graphite-bearing rock at this mine is a weathered quartz-graphite schist practically identical with that at the Chester Graphite Company's mine. The strike varies from N. 30° E. to N. 55° E. and the dip from 30° to 35° SE. The workings all appear to lie in a single belt of graphitic schist, which varies from 6 to 30 feet in width. The hanging wall in one portion of the 80-foot level was pegmatite, and in a number of places dikes of aplitic granite were found cutting the graphitic schist. The quantity of graphitic rock blocked out by these workings is unquestionably very large.

The mill of this company is located close to the mine and about 1 mile from Pikeland, the nearest station on the railroad. A wet process of concentration is used, the equipment including jaw crusher, crushing rolls, log washers, revolving drier, hexagonal dry screens, burrstone mills, and bolting machines.

Girard Graphite Company.—The mine and the mill of this company are located about 2 miles southwest of Kimberton. The property is now idle. The first excavations here were for iron ore, but recently graphite has been the mineral sought. The large open pit about 400 by 300 feet was excavated principally in mining the iron ore. The pit and a 65-foot vertical shaft near by were filled with water at the time of the writer's visit (October, 1909). None of the graphitic rock utilized could be seen, but the mill concentrates showed that some of it must have been quite coarse grained, some of the flakes of mica (muscovite) and graphite being one-fourth of an inch across. Some of the crushed material seen in the log washers was granite-pegmatite. The mill equipment includes log washers, drier, pneumatic separators, burrstone mills, and classifiers.

American Flake Graphite Company.—The mine and the mill of this company are located about 3 miles southwest of Phoenixville and 1½ miles southeast of Kimberton station. The shipping point is Harveyville on the Pennsylvania Railroad about midway between the mine and Phoenixville. The plant is a new one and had not been in operation long at the time of the writer's visit. The mine is a single pit on a southern hill slope. It is about 150 feet long from northwest to southeast, 40 feet wide, and 30 feet in maximum depth.

The rock is a decomposed quartz-graphite schist containing relatively little mica, and so soft that it can be mined with pick and shovel. Its general strike is N. 15° E. and dip 30° to 35° SE. The pit exposes a thickness of at least 20 feet of this graphitic schist. There are a few lenses and stringers of gray quartz up to 4 inches wide and of fine-grained, much decomposed granite-pegmatite up to 1½ feet across. The pegmatite dikes are largely quartz and feldspar; they carry little or no graphite, and are discarded in the mining.

The ore is loaded into a mine car, which is hauled by a mine cable up an inclined trestle to the upper floor of the mill. The concentration is accomplished by a combination of wet and dry processes. The equipment includes crushing rolls, log washers, pneumatic separators, and flotation separators of special design. The finishing is accomplished in the usual manner with French burrstone mills and screens.

It is stated that the graphitic rock assays from 7 to 16 per cent graphite and that only 9 to 10 tons of the rock are required to yield 1 ton of concentrate. The separation effected is certainly unusually clean.

BERKS COUNTY.

Graphite has formerly been mined at several places in Berks County. None of the properties are at present worked and they have not been visited by the writer. The following descriptions were published in 1901 by T. C. Hopkins:[a]

At Boyertown, in eastern Berks County, a graphite mine was opened many years ago and some crude graphite shipped, but the industry apparently proved unprofitable and was soon abandoned. In the summer of 1899 the Boyertown Graphite Company reopened the mine and erected a refining mill where the graphite is separated and prepared for market. It occurs here in a partially disintegrated mica schist in which a shaft has been sunk to a depth of 50 feet, through which the ore mined in underground galleries is elevated to the surface and transferred by wheelbarrow to the crusher.

Near Mertztown, in northern Berks County, the Penn Graphite Company (of Allentown) operates a productive graphite mine and well-equipped refining mill. The mine has been operated at intervals for twenty years by different parties, but since the present company took possession in 1897 it has been in continuous operation and worked more systematically than formerly. It is now producing about 2 tons per day—1½ tons of flake graphite and a half ton of lower grade used for graphite paint. The sand, which is a by-product from the refining process, is sold to the foundries for molding sand. The graphite occurs in a lenticular vein in a coarse-grained sandstone. The maximum thickness of the lens or vein is 39 feet, and 28 per cent of the vein material is graphite. It is mined with pick and shovel in galleries at different levels and elevated to the surface by horsepower. The material is then crushed, washed, and further refined by air currents, and then packed for shipment.

TEXAS.

The following description of occurrences of graphite in the Llano region of Texas was furnished by Sidney Paige, of the United States Geological Survey:

Graphite-bearing schists are widely distributed throughout the pre-Cambrian series, though the content of graphite is very variable. In most instances the graphite schists are associated with limestone or marble, a natural occurrence since carbonaceous shales are often associated with limestone strata. Often these schists can be traced for long distances.

Graphite-bearing schists were noted at many localities, but since only one of these is as yet considered of importance a description of the occurrence at this locality will serve as a measure of those left

[a] Hopkins, T. C., Graphite and garnet. Industries in Pennsylvania—Where the minerals occur—The uses to which they are put and their values. Mines and Minerals, March, 1901, p. 352.

undescribed; for, it may be said in general, that it would not be advisable to spend money upon prospecting or testing at other localities until the deposit in question is proved a commercial success. If any exception be made to this statement it would be that perhaps certain beds carry sufficient graphite to be of value as a paint pigment, in the industrial manufacture of which a very impure graphite can be used.

The locality which has received and warranted the most attention is 1⅞ miles due south of Lone Grove, is approximately 1,500 feet west of Little Llano River, and about 800 feet north of the Houston and Texas Central Railroad. The property is controlled by R. H. Downman, of New Orleans.

The graphite occurs in graphitic schists associated in this vicinity with considerable limestone. Granite and pegmatite intrusions have locally disrupted the beds, and at a first glance the impression might be formed that pegmatite had introduced the graphite. A careful examination of the graphite bunches in the pegmatite shows, however, that they represent broken fragments of schist. A specimen was polished and etched with hydrochloric acid, which in dissolving out the calcite contained between the laminæ of the schist fragments showed clearly the schistose nature of the graphite.

The graphite-bearing schists can be traced with interruptions for half a mile northwestward from a point a little west of the railroad bridge, through the present workings, to a point where the series disappears beneath overlying Cambrian sandstones. Graphite is also reported across the river to the south in the same trend.

The deposit has been prospected by a shaft with underground workings and by a number of surface cuts, four or more, over a distance of about 500 feet.

A private report made in 1902 by William Young Westervelt and furnished by the courtesy of Mr. R. H. Downman contains much interesting data on this property, and the following notes are copied or abstracted from it.

An average sample taken over the length of a 72-foot prospect cut showed a carbon content of 11.45 per cent.

A number of tests were made with the following results:

A general sample was made up of all the samples secured underground and crushed to pass a 10-mesh sieve. It was assayed and found to contain 14.50 per cent graphite. * * * Further tests indicate that ore containing 14.50 per cent carbon (the assay of the made-up general sample) will yield from 1 to 4 per cent of its weight of flaked graphite[a] containing from 56 to 40 per cent carbon, whose impurities contain less than 2 per cent each of iron (Fe) and lime (CaO), the most common of the objectionable impurities for crucible manufacture. Also * * * that fine graphite could be produced amounting to from 27 to 28 per cent of the original ore and containing from 29.75 to 25.80 per cent pure graphite, the total recovery of graphite in the form of flake and fines being 60 to 61 per cent of the total graphite in the original sample.

Other tests on specially selected samples were made, but need not be presented here.

Much of the territory included in this property has not been adequately tested by surface cuts, and it is believed that possibilities exist for the successful establishment of a graphite industry at this point.

[a] Too large to pass a 60-mesh sieve.

South of Llano, about 2 miles, graphite schists trending in a northwest-southeast direction toward Sharp Mountain may be observed. In this vicinity, perhaps, with the exception of the property already described, exists the most favorable opportunity to prospect, though graphite schists occur at many localities throughout the region. It must be borne in mind, however, when making an estimate of the graphite content of a given band of schist that appearances are very deceptive, a very little graphite making a very striking showing.

UTAH.

During 1909 a mine was opened near Brigham City, in Boxelder County, Utah, by the Humber Mining Company, of Salt Lake City. The erection of a plant at Ogden is contemplated, where the material will be used in the manufacture of paint. According to Hoyt S. Gale,[a] of the United States Geological Survey, the deposits are located on Three Mile Creek between Brigham and Perry. They are carbonaceous schists, which form part of an extensive series of altered sediments. The beds as exposed in the shallow prospects are at least 20 feet in thickness and appear to be persistent for considerable distances. The rock when rubbed takes on a black lustrous polish similar to that shown by certain slates carrying amorphous graphite. The rock has not a greasy feel, but is free from coarse grit. An analysis made in the laboratory of the United States Geological Survey of a composite sample showed 3.48 per cent of fixed carbon. A selected sample of the most carbonaceous-looking material showed 5.59 per cent of fixed carbon. All of this carbon burns off readily in the ordinary Bunsen flame, and is therefore not graphite. Though probably lacking some of the resistant qualities of slates containing amorphous graphite, the material may prove marketable as a paint pigment.

WISCONSIN.

The plant of the Pioneer Graphite Company near Junction City, in Portage County, Wis., was partly destroyed by a cyclone in November, 1908. It resumed operation again in August, 1909, but was soon afterwards destroyed by fire. Since then there has been no production.

The Wisconsin Graphite Company, with mine near Junction City and mill at Stevens Point, continued operation in 1909. The amorphous graphite mined was pulverized and air-floated. A part was marketed dry; another part was manufactured by this company into paint and other products.

OTHER STATES.

In California the Dixon Graphite and Milling Company, of Oakland, mined a few tons of graphite near Point Arena in Mendocino County. Part of this was refined, but none was marketed in 1909. The Georgia quarries yielding low-grade amorphous graphite, used as

[a] Gale, Hoyt, S., Supposed deposits of graphite near Brigham, Utah: Bull. U. S. Geol. Survey No. 430, 1909, pp. 639–640.

a fertilizer filler, which were idle in 1908, resumed operation in 1909. One of these firms, the Cherokee Graphite and Chemical Company, was sold to the Emerson Brick Company, of Atlanta, Ga. The material is used to reduce high-grade phosphates to the phosphorous percentage usually used in agricultural purposes. In Idaho a graphite mine was opened by Hampton & Griffith, near Ketchum, in Blaine County. Some graphite has been mined and was milled or marketed during 1909. It is reported to belong to the amorphous variety. In Massachusetts a few tons of graphite were mined in 1909 by the Imperial Graphite Company, of Pennsylvania, from the mine of the Massachusetts Graphite Company, near Starbridge, in Worcester County. In Montana the Crystal Graphite Company, of Dillon, was reported idle in 1909. In Nevada the Carson Black Lead Company reported a small output from its mine and mill at Carson City. In New Mexico the Standard Graphite Company, of Scranton, Pa., with mine near Raton, N. Mex., is reported to be out of business. Rhode Island properties were all reported idle in 1909.

NOTES ON FOREIGN GRAPHITE.

Japan.—A recent report of the Japanese Government, printed in English,[a] gives a summary of the graphite industry of Japan. The features likely to interest American readers are given below. The yearly production of graphite has fluctuated from 195,000 pounds to 480,000 pounds since 1900. The output has been too small to supply the domestic demand, and most of the graphite consumed has been imported from Chosen (Korea), Ceylon, etc. The Japanese graphite belongs to both the crystalline and the amorphous varieties. Bedlike deposits are the most common, though veinlike deposits also occur. Among the bedlike deposits two varieties occur, (1) those in which the graphite forms small flakes disseminated through Archean gneiss, and (2) masses of amorphous graphite in Paleozoic slates and Mesozoic shales. All the important deposits are in Nippon, the largest of the Japanese islands. The bulk of the production comes from the deposits of crystalline disseminated graphite. These are situated in the provinces of Hida and Etchu in central Nippon. The deposits of amorphous graphite belonging to the second class mentioned above occur in the provinces of Rikuzen in northern Nippon and Nagato and Satsuma in southern Nippon. It has been stated that these represent metamorphosed coal seams, and in at least two cases the metamorphism has been traced to intruded masses of igneous rock. Graphite from Kataya in the province of Kaga in central Nippon, said to occur as a vein deposit, is of such high quality that it is used for pencil manufacture.

Natal.—A report recently issued by the Natal government (see bibliography below) throws light on the origin of certain graphite deposits in that country. Graphite occurs in Natal either (1) as small flakes irregularly disseminated through crystalline dolomites and schists, or (2) as seams of amorphous material which represent impure coal beds altered by the intrusion of dolerite. Analysis of a

[a] Mining in Japan, Past and Present, published by the Bureau of Mines, Japan, 1909. Section on graphite, pp. 133–135.

sample of graphitic dolomite from near Port Shepstone in southern Natal showed 16 per cent of graphite by weight. The graphitic dolomite is at one place traversed by small seams of graphite about one-fourth of an inch wide through most of their length, but occasionally enlarging to nodules, the largest of which was 4 by 6 by 9 inches. The richest portions of these nodules analyzed about 40 per cent graphite.

The percentage of graphite in those deposits which represent impure coal beds metamorphosed by the intrusion of igneous rock varies from about 5 to nearly 50 per cent in the samples analyzed. There has been no important commercial development of the Natal deposits.

LITERATURE.

The literature dealing with graphite is voluminous and contains many abstracts and quotations. The following list is selected, so far as possible, to avoid duplication and yet to convey all the important information relative to the occurrence and production of the mineral in the United States. Under each reference the general scope of the paper is described and attention is directed to its most important features. Canadian publications are not listed unless they are of general interest or include mention of United States deposits. For references to the voluminous Canadian literature and many foreign publications the reader is referred to the monograph on graphite, by Fritz Cirkel, published by the Canadian Government.

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[a] The numerals given in this index are the numbers prefixed to the entries in the bibliography, pp. 29–34.

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1. Acheson, E. G., Seventeen years of experimental research and development. (Privately published.) Mr. Acheson chronicles his discovery and development of the processes of manufacturing carborundum, graphite, and the so-called "deflocculated" graphite. 14 pages. Illustrated.

2. ——— Discussion of artificial graphite: Mineral Industry, vol. 8, 1899, pp. 351, 352.

3. Bailey, W. S., and Stewart, C. A., Note on the occurrence of graphite schist in Tuxedo Park, N. Y.; Econ. Geology, vol 3, 1908, pp. 535–538. Observations of the New York and New Jersey Highlands west of the Hudson River indicate that graphite occurs (1) as a component of Franklin limestone, (2) in gneisses which may be in part altered sediments but are in places certainly mashed pegmatites, (3) in coarse granite dikes and pegmatites, and (4) in fine-grained quartzitic micaceous schists, especially where these are associated with pegmatites. The last-named occurrences are the most important. Concentrating works at Bloomingdale, Highbridge, and near Brookside have all failed. Describes in detail the occurrence of graphite in schists at Tuxedo Park. The graphite plates are usually in parallel intergrowth with biotite plates. The graphitic schist is believed to be the product of metamorphism of a sediment rich in organic matter. The pegmatite is graphitic only when near the schist or where it carries fragments of this rock.

4. Ball, S. H., Graphite in the Haystack Hills, Laramie County, Wyo.: Bull. U. S. Geol. Survey No. 315, 1906, pp. 426–428. Describes character, origin, and economic value of undeveloped graphite deposits of this region. Graphite formed through contact metamorphic effects of granite and pegmatite which intruded carbonaceous sediments.

5. Bastin, Edson S., Graphite: Mineral Resources U. S. for 1908, vol. 2, U. S. Geol. Survey, 1909, pp. 721–731. Describes in detail the graphite deposits of Warren, Essex, and Saratoga counties, N. Y., and of Rhode Island and New Mexico.

6. ——— Origin of certain Adirondack graphite deposits: Econ. Geology, vol. 5, pp. 134–157. All these deposits have resulted directly or indirectly from the metamorphism of carbonaceous sediments. There are two principal groups: (1) Those which originated through dynamic (regional) metamorphism alone, and (2) those which have been affected by both dynamic and igneous (contact) metamorphism. Most of the disseminated deposits of crystalline graphite which are worked belong to the first class. To the second or contact metamorphic class belong the deposit at Lead Hill, near Ticonderoga, and the deposit worked by the Crown Point Graphite Co., just north of Chilson Lake. A study of quartz associated with the graphite at the Lead Hill mine indicates that the temperatures at which the graphite and associated minerals crystallized probably did not exceed 575° C.

7. Brown, C. W., in Bastin, Edson S. Graphite: Mineral Resources U. S. for 1908, vol. 2, U. S. Geol. Survey, 1909, pp. 731–732. Describes the occurrence of graphite at Cranston, R. I., near Providence, and near Tiverton, in Newport County. The rocks are graphitic shales and schists and two analyses of the Cranston rock showed respectively 25 and 41 per cent graphite. Some of the Rhode Island material has been ground for use as a paint pigment and foundry facings, but the development has been sporadic.

8. Brumell, H. P. H., Canadian graphite: Jour. Canadian Min. Inst., vol. 10, 1907, pp. 85–104. Republished with illustrations in Canadian Min. Jour., vol. 28, 1907, pp. 163–171. Abstract in Min. World, vol. 26, 1907, p. 627. Describes the general character, distribution, and origin of graphite. Gives the history of the industry in Canada; Canadian methods of concentrating, markets, uses, and statistics of production.

9. Brumell, H. P. H., Graphite concentration: Jour. Canadian Min. Inst., vol. 12, 1909, p. 205. Reprinted in the Canadian Min. Jour., vol. 30, pp. 267–272. 1909. Describes the processes of concentration used in various Canadian mills.

10. ——— Regarding lead-pencils: Canadian Min. Jour., vol. 28, 1907, p. 173. Brief history of the industry.

11. Carter, W. E. H., On the graphite industry in Canada during 1902: Mineral Industry, vol. 11, 1902, pp. 349–351.

12. Chester, Frederick D., The flake graphite industry in the United States: Eng. and Min. Jour., vol. 88, 1909, pp. 785, 786, and 824. Discusses the causes of the many failures in the mining and milling of flake graphite. Cites certain bad practices in graphite concentration and gives formula for estimating value of finished product to be obtained from concentrates containing different percentages of graphite.

13. Cirkel, Fritz, Graphite; its properties, occurrence, refining, and uses: Dept. of Mines, Ottawa, Canada, 1907, 307 pages. The best general treatise on this mineral. Includes detailed descriptions of Canadian graphite deposits, descriptions of foreign occurrences, and bibliography. Illustrated. Reviews theories of T. Sterry Hunt, Weinschenk, Osann, and others. Regards the disseminated deposits of Canada as derived by metamorphism from originally carbonaceous sediments. Reviewed by Frank L. Hess, Econ. Geology, vol. 4, pp. 661–666, 1909, and by H. Mortimer Lamb, Eng. and Minn. Jour., vol. 85, pp. 360–361. 1908.

14. Cushman, A. S., The preservation of iron and steel: Office of Public Roads, Dept. Agri., Bull. 35, 1909. Describes tests on the rust-preventing qualities of graphite and other paint pigments when applied to iron and steel. Experiments appear to show that graphite is a rust stimulator and not a rust inhibitor, and hence that it should not be applied as a first coating to iron or steel. It may be serviceable as an outer coating.

15. Dana, E. S., System of Mineralogy, 6th ed., 1904, pp. 7–8. Mineralogical characters, composition, localities, etc.

16. Electrochemical and Metallurgical Industry, The works of the International Graphite Co., at Niagara Falls, vol. 7, 1909, pp. 187–188. Describes the general equipment of this plant in 1909, without giving details of the electrochemical processes. Three half-tone illustrations.

17. Fitzgerald, F. J. (chemist of the International Acheson Graphite Co.), The conversion of amorphous carbon to graphite: Jour. Franklin Inst., vol. 154, 1902, pp. 321–348. Reviews various methods of producing graphite artificially and describes in detail the Acheson process.

18. ——— The Ruthenburg and Acheson Furnaces: Electrochemical and Metallurgical Industry, vol. 3, 1905, pp. 416–417. Detailed descriptions and diagrams showing construction of the Acheson graphite furnaces.

19. Frazer, Persifor, Relations of the graphite deposits of Chester County, Pa., to the geology of the rocks containing them: Trans. Am., Inst. Min. Eng., vol. 9, 1881, pp. 730–733. Describes graphite mine in town of Windsor, Chester County, and method of mining and milling.

20. Gale, Hoyt S., Supposed deposits of graphite near Brigham, Utah: Bull. U. S. Geol. Survey No. 430, pp. 639–640. Abstract in Bastin, Edson, S., Graphite: Mineral Resources U. S. for 1909, vol. 2, U. S. Geol. Survey, 1911; also in Min. World, vol. 33, p. 236, 1910.

21. Goss, W. F. M., Tests of graphite on ball bearings, with explanatory charts: Industrial World, April 20, 1908. Six series of tests were made by Professor Goss, of Purdue University, on a specially designed ball-bearing testing machine using successively kerosene, lard oil, and vaseline, and mixtures of each of these with 4 per cent, by weight, of Dixons Ticonderoga flake graphite. In all cases the presence of the graphite resulted in a marked decrease in frictional resistance.

22. Hatch, F. H., Report on the mines and mineral resources of Natal, pp. 111–115, 1910. Abstract in Bastin, Edson S., Graphite: Mineral Resources U. S. for 1909, vol. 2, U. S. Geol. Survey, 1911. Graphite occurs (1) as small flakes irregularly disseminated through crystalline dolomites and schists; (2) as beds of amorphous graphite formed by contact metamorphism of impure coal seams by intrusive rocks. There has been no important commercial development.

23. Hayes, C. W., and Phalen, W. C., Graphite deposits near Cartersville, Ga.: Bull. U. S. Geol. Survey No. 340, 1907, pp. 463–465. Discusses character, origin, and uses of graphitic talcose slates of Cartersville region. Probably formed by metamorphism of a carbonaceous clay shale.

24. Hess, F. L., Graphite mining near La Colorado, Sonora, Mexico, Eng. Mag., vol. 38, 1909, pp. 36–48. Abstract, in Bastin, Edson S., Mineral Resources U. S. for 1908, vol. 2, U. S. Geol. Survey, 1909, p. 734. The deposits were discovered in 1867, preliminary work begun in 1891, and commercial operations in 1895. The graphite bed now worked reaches 9 to 10 feet in thickness, though locally reduced through squeezing to a thin seam, while in other places bulging to 24 feet. The wall rock is in most places a sandstone, though locally granite. Limestone also occurs near the mine. The graphite probably represents a coal bed of Upper Triassic age, which was graphitized by the intrusion of granite. The graphite is of the amorphous variety, and it is excavated from extensive underground workings and hauled by 10 to 14 mule teams 20 miles to the railroad at La Colorado. From there it is shipped to the factory of the operating company—the United States Graphite Co., at Saginaw, Mich. Map and sketch plan of vicinity of mines. Seven half-tone illustrations.

25. Hopkins, T. C., Description of graphite properties near Chester Springs, Chester County, Pa.: Mineral Industry, vol. 7, 1898, p. 383.

26. ——— Description of the occurrence of graphite in Berks County, Pa.: Mineral Industry, vol. 8, 1899, p. 350. Quoted in full in Bastin, Edson S., Graphite: Mineral Resources U. S. for 1909, vol. 2, U. S. Geol. Survey, 1911.

27. ——— Graphite and garnet: Mines and Minerals, vol. 21, 1901, p. 352. Briefly describes characters and uses of graphite. Mentions the principal localities of graphite production in the world and describes in some detail mines at Chester Springs and Byers, in Chester County, and at Boyertown and Mertztown, in Berks County, Pa.

28. Hyde, F. S., Discussion of assay of graphite by blast and fusion: Mineral Industry, vol. 9, 1900, pp. 380–383.

29. ——— On some characteristics of natural graphite: Mineral Industry, vol. 16, 1907, pp. 574–575.

30. ——— Some characteristics of natural graphite: Eng. and Min. Jour., vol. 85, 1908, pp. 255–256. Describes chemical and physical tests for distinguishing different kinds of natural graphite.

31. Ihne, F. W., Graphite in the South: Manufacturers' Record, vol. 54, 1909, pp. 134–138. Discusses the general character and mode of occurrence of graphite and describes in some detail the deposits in the South Atlantic States. Describes in detail the concentration process of the Southern Graphite Co., of Graphiteville, N. C.

32. ——— Graphite in the United States: Min. Sci., vol. 60, 1909, pp. 297–298, 316–318, 343–346. Describes the occurrence, distribution, and mining of graphite in the United States. Illustrated.

33. ——— General discussion of character of graphite and of graphite mining: Mineral Industry, vol. 17, 1908, pp. 489–497. Particularly full description of the Clay County, Ala., deposits.

34. Imperial Institute, Bulletin of the, Graphite and its uses, vol. 4, 1906, pp. 353–360; vol. 5, 1907, pp. 70–85. Abstract in Canadian Min. Jour., vol. 28, 1907, pp. 171–173. General discussion of the character, occurrence, uses, and concentration of graphite. Summary of its distribution in various parts of the world. Some references.

35. Iron Age, The, Acheson graphite lubricant, May 23, 1907. Discusses the lubricating value of "deflocculated" artificial graphite.

36. Keith, Arthur, Mount Mitchell (N. C.-Tenn.) folio (No. 124), Geol. Atlas U. S., U. S. Geol. Survey, 1905. Describes character and utilization of graphitic schists near Graphiteville, N. C.

37. Kemp, J. F., Graphite in the eastern Adirondacks, N. Y.: Bull. U. S. Geol. Survey No. 225, 1903, pp. 512–514. The graphite deposits are confined to Algonkian rocks and occur (1) in pegmatite veins, (2) as veinlets of graphite, (3) in quartzites, and (4) in crystalline limestones associated with gneissoid strata. Deposit at Chilson Hill near Ticonderoga is briefly described and referred to pegmatite class. Graphitic veinlets at Split Rock on Lake Champlain are described. Description of graphitic quartzites at Hague and a few other localities. These quartzites are regarded as metamorphosed bituminous shales. Milling process at Hague described. Occurrence of graphite in crystalline limestone briefly described.

38. Kemp, J. F., and Newland, D. H., Preliminary report on the geology of Washington, Warren, and parts of Essex and Hamilton counties, N. Y.: Fifty-first Ann. Rept. N. Y. State Mus., 1897, vol. 2, pp. 537–540. Describes the

rocks of Hague as gneisses of several varieties, mostly striking northwest. Crystalline limestone occurs at two points and pre-Cambrian sedimentary schists at several localities. The best exposures of such schists are at the mine at Graphite. The graphite deposit is an impregnation or dissemination of graphite in quartzite. Gives microphotographs of the garnet-sillimanite wall rock. Preliminary concentration at this time was by California stamps and buddles. The further concentration process at the finishing mill at Ticonderoga is secret. Figure 4 is a map and structure section of the locality.

39. LAW, E. STANLEY, Notes on a useful mineral (graphite): The Mineral Collector, vol. 12, pp. 169–173, 180–184. Discusses characters, uses, and production of graphite. Quotes Kemp on occurrence of graphite in New York. Describes in some detail the mode of occurrence and mining and milling methods in Chester County, Pa. Briefly describes the Ceylon occurrences and the methods of artificial production.

40. LEE, WILLIS T., in Bastin, E. S. Graphite: Mineral Resources U. S. for 1908, vol. 2, U. S. Geol. Survey, 1909, p. 733. Describes the graphite deposit near Raton, in Colfax County, N. Mex. The deposit is nearly horizontal, and represents a coal bed graphitized by the intrusion of diabase. A representative sample analyzed 77 per cent graphite. The material has been utilized somewhat in paint manufacture.

41. MEEKS, REGINALD, Discussion of market for graphite: Mineral Industry, vol. 17, 1908, pp. 497–500.

42. MERRILL, GEORGE P., The nonmetallic minerals; their occurrence and uses, 1910, pp. 6–14. General discussion of the character, occurrence, origin, and uses of graphite. Short bibliography.

43. MILLS, FRANK S., The economic geology of northern New York: Eng. and Min. Mag., vol. 85, 1908, p. 397. Describes particularly the property of the Macomb Graphite Company, in St. Lawrence County. The graphite is disseminated as small flakes in quartz schists. A small amount of development work has been done.

44. MINES, BUREAU OF, Dept. of Agriculture and Commerce, Japan, Mining in Japan, Past and Present, 1909, pp. 133–135. (Two pages in English.) Abstract in Bastin, Edson S., Graphite: Mineral Resources U. S. for 1909, vol. 2, U. S. Geol. Survey, 1911. Discusses domestic production and imports and briefly describes the principal occurrences. The bulk of the Japanese consumption is imported from Ceylon, Korea, etc. The domestic occurrences are all in the principal Japanese island of Nippon. Most of the output is crystalline graphite, which occurs disseminated in small flakes in gneiss. Amorphous deposits, probably produced by the contact metamorphic effects of igneous rocks on coal seams, are also worked.

MINERAL INDUSTRY, 1892 to 1909, vols. 1 to 19. Pub. by Eng. and Min. Jour. Annual statements of the progress of the graphite industry. The special features of most importance as regards graphite are as follows:

45. Mineral Industry, vol. 2, 1893, pp. 335–342. Describes foreign and domestic occurrences and uses, with numerous references to foreign literature.

46. ——— vol. 6, 1897, pp. 387–390. Discusses particularly the use of graphite paint for metallic surfaces.

47. ——— vol. 7, 1898, pp. 382–387. Description, by T. C. Hopkins, of graphite properties near Chester Springs, Chester County, Pa., with quotation from Weinschenk on mode of occurrence in Bavaria and Bohemia.

48. ——— vol. 8, 1899, pp. 348–352. Description, by T. C. Hopkins, of the occurrence of graphite in Berks County, Pa. Quotation in full in Bastin, Edson S., Graphite: Mineral Resources U. S. for 1909, U. S. Geol. Survey, 1911. Discussion, by E. G. Acheson, of artificial graphite.

49. ——— vol. 9, 1900, pp. 378–383. Discussion, by F. S. Hyde, of assay of graphite by blast and fusion.

50. ——— vol. 10, 1901, pp. 367–373. Two pages devoted to artificial graphite.

51. ——— vol. 11, 1902, pp. 343–353. Discussion, by W. E. H. Carter, of the graphite industry in Canada during 1902. Two pages on artificial graphite.

52. ——— vol. 12, 1903, pp. 183–187. Devotes 1½ pages to the Ceylon deposits.

53. ——— vol. 14, 1905, pp. 311–312. A short description (one-third of a page) of the graphite deposits near Charlottesville, Va.

54. MINERAL INDUSTRY, vol. 16, 1907, pp. 567–575. Description, by F. S. Hyde, of some characteristics of natural graphite, and descriptions, by other writers, of occurrence of graphite in Alabama, New Jersey, and Wyoming.

55. ——— vol. 17, 1908, pp. 488–500. General discussion, by F. W. Ihne, of graphite and graphite mining. Particularly full description of the Clay County, Ala., deposits. Discussion, by Reginald Meeks, of market for graphite.

56. ——— vol. 18, 1909, pp. 384–390. Devotes 2½ pages to foreign graphite occurrences.

57. MOFFIT, FRED H., The Nome region: Bull. U. S. Geol. Survey No. 314, 1907, pp. 139–140. Abstract in Bastin, Edson S., Graphite: Mineral Resources U. S. for 1909, U. S. Geol. Survey, 1911. Describes briefly (one page) the character and mode of occurrence of graphite on the south side of the Kigluaik Mountains, Seward Peninsula, Alaska.

58. MOISSAN, HENRY, The electric furnace (authorized translation by Victor Lehner). 1904, pp. 50–79. Describes the behavior of various natural terrestrial graphites upon heating or treatment with certain reagents, also graphites obtained from the terrestrial iron of Greenland and from several iron meteorites. Describes the process of formation and the characters of various artificial graphites produced both by simple elevation of temperature and by the solution of carbon in different metals. The experiments appear to indicate that graphite formed at high temperatures is less readily attacked by the usual reagents than that formed at lower temperatures. The swelling exhibited by certain graphites when heated with aqua regia is believed to be due to the sudden evolution of gases. All the artificial graphites produced by simple elevation of temperature were nonswelling; all obtained from fusion with metals exhibited swelling. The temperature of swelling lies between 165° and 175° C.

59. NASON, FRANK L., Geological studies of the Archean rocks: Ann. Rept. of State Geologist of New Jersey, 1889, pp. 27–29 and 64–65. Describes the distribution of several belts of graphitic schists in the New Jersey Highlands.

60. NEWLAND, D. H., The mining and quarry industry of New York State: Bull. New York State Mus., Nos. 93, 102, 112, 120, 132, 142, 1904–1909. Annual statistics of the production of graphite and reports on the progress of the industry. The more important locality descriptions are listed below:

61. Bull. 102, 1905, pp. 73–78. Describes briefly mines at "Graphite," in Warren County, Rock Pond, and Mineville, in Essex County, and Dresden, in Washington County. Devotes one-half page to milling methods.

62. Bull. 120, 1907, pp. 29–31. Describes briefly mines near Conklingville, in Saratoga County, and near Rossie, in St. Lawrence County. Discusses effects of presence of mica and influence of size of graphite flake in concentration.

63. Bull. 142, 1909, pp. 37–38. Describes the graphite property of W. H. Faxon, near "Graphite."

NEWLAND, D. H., KEMP, J. F., and. *See* Kemp and Newland.

64. NICHOLAS, F. C., A novel graphite washing plant: Min. World, vol. 28, 1908, p. 18. Describes concentrating process at plant of Empire Graphite Company, Saratoga County, N. Y.

65. OGILVIE, IDA H., Geology of the Paradox Lake Quadrangle, N. Y.: Bull. N. Y. State Mus. No. 96, 1904. Describes sillimanite gneiss associated with graphitic rock at "Graphite" (6 lines, p. 495). Describes mode of occurrence of graphite at "Graphite," Warren County, and at Rock Pond, Essex Co. (pp. 503–505). Cites Weinschenk on origin of graphite (10 lines, p. 504). "The Adirondack graphite is plainly of two kinds—that present as an accessory constituent of the limestone and quartzite, and that occurring in a secondary position along fault lines." The former is regarded as an original carbonaceous constituent of sediments, graphitized by dynamic metamorphism. The latter represents a part of the graphite which was volatilized during the same metamorphism transported somewhat and later sublimed along fracture planes.

66. Paint Manufacturers' Association of the United States, Philadelphia, Pa. Scientific Section, 1908. Preliminary report on steel test fences. Describes methods of testing the protective qualities of graphite and other pigments. Results not reported.

PHALEN, W. C., HAYES, C. W., and. *See* Hayes and Phalen.

67. PRATT, J. H., Graphite: Mineral Resources U. S. for 1903, U. S. Geol. Survey, 1904, pp. 1121–1129. Describes processes of making artificial graphite. Quotes Young on assaying graphite ores.

68. PRATT, J. H., Graphite: Mineral Resources U. S. for 1904, U. S. Geol. Survey, 1905, pp. 1157–1167. Good brief summary of occurrence and uses.

69. ——— The Mining Industry of North Carolina: North Carolina Geol. Survey Econ. Papers Nos. 4, 6, 7, 8, 9, 11, 14. Annual statistics of production and record of the progress of the graphite industry. The most important detailed description is in No. 6, 1901, which describes the occurrence of graphite disseminated in gneiss in McDowell, Wake, and Catawba counties, and in pegmatite in Alexander County.

70. RICHARDS, J. W., The electrochemical industries of Niagara Falls: The International Acheson Graphite Co., 1902, pp. 52–54. Describes in detail the process of manufacture of artificial graphite. Illustration of furnaces.

71. SADLER, S. S., Determining ash in graphite: Australian Mining Standard, December 11, 1907. Small quantities of magnesia are added to the samples to prevent the residue from fusing to the crucible. The ash can then be readily removed and analyzed.

72. SMITH, EUGENE A., Graphite in Alabama: Mineral Industry, vol. 16, 1907, pp. 567–568. Includes a description (two-thirds page) of the Clay County deposits.

73. SMITH, G. O., Graphite in Maine: Bull. U. S. Geol. Survey No. 285, 1906, pp. 480–483. Describes origin, mode of occurrence, and possible utilization of graphite at Madrid, Franklin County, and at Yarmouth, Cumberland County. Regards graphite occurring in pegmatite at Yarmouth as of magmatic origin.

74. ——— Graphite: Mineral Resources U. S. for 1905, U. S. Geol. Survey, 1906, pp. 1265–1269. Describes the occurrence of graphite as an original constituent of certain granitic rocks; discusses the kinds of graphite best suited to the manufacture of crucibles and of lead pencils.

75. ——— Graphite: Mineral Resources U. S. for 1906, U. S. Geol. Survey, 1907, pp. 1139–1143. Summarizes the characters, occurrence, and uses of graphite.

76. SMITH, PHILIP S., Investigations of the mineral deposits of Seward Peninsula: Bull. U. S. Geol. Survey No. 345, 1908, p. 250. Abstract in Bastin, Edson S., Graphite: Mineral Resources U. S. for 1909, vol. 2, U. S. Geol. Survey, 1911. Describes briefly (one-half page) the character and mode of occurrence of graphite on the north side of the Kigluaik Mountains, Alaska.

77. ——— Recent developments in southern Seward Peninsula: Bull. U. S. Geol. Survey No. 379, 1909, pp. 300–301. Abstract in Bastin, E. S., Graphite: Mineral Resources U. S. for 1909, vol. 2, U. S. Geol. Survey, 1911. Describes briefly (three-fourths page) the character and particularly the method of development of the graphite deposits on the north side of the Kigluaik Mountains, Alaska.

78. STANDISH, ALFRED, The electric furnace, 1908, pp. 142–149. Good summary of processes and principles of the commercial production of artificial graphite and diagrams of electric furnaces used.

STEWART, C. A., BAILEY, W. S., and. *See* Bailey and Stewart.

79. TOWNSEND, C. P., The artificial production of graphite: Elec. World and Engineer, vol. 37, 1901, pp. 546–550. An excellent review of the various methods of the artificial production of graphite, and a discussion of the chemical changes involved.

80. WALCOTT, C. D., Pre-Cambrian fossiliferous formations: Bull. Geol. Soc. Am., vol. 10, 1899, p. 227. Devotes one paragraph to the mine at "Graphite" in Hague, Essex County, N. Y. "The appearance [of this graphitic bed] is that of a fossil coal bed, the alteration having changed the coal to graphite and the sandstone to indurated, garnetiferous, almost quartzitic sandstones." Reproduces photograph of graphitic bed (pl. 22).

81. WALKER, JOHN A., The manufacture and use of lead pencils: Graphite Tradesman (published by Joseph Dixon Crucible Co.), August 15, 1906. History and method of lead-pencil manufacture.

82. WATSON, THOMAS L., Mineral Resources of Virginia, 1907, pp. 188–190. Published by Jamestown Exposition Commission.) Mentions the localities at which graphite has been found in Virginia. No detailed descriptons.

83. WHITE, DAVID, Some problems of the formation of coal: Econ. Geology, vol. 3, 1908, p. 298. The discovery of hydrocarbon-bearing strata composed largely of such organisms (algæ) in rocks as old as the Ordovician strongly suggests an algal origin for the graphites interbedded in still older metamorphic sediments of the Laurentian or Algonkian.

MAGNESITE

By Charles G. Yale.

PRODUCTION.

The production from the magnesite deposits of California in 1909, the only ones commercially utilized in the United States, was 9,465 short tons crude, valued at $37,860, as compared with 6,587 tons crude, valued at $19,761, in 1908. Aside from the increase in quantity in 1909, it is to be noted that there was an advance of 33⅓ per cent in price of the crude ore, the average having risen from $3 per ton in 1908 to $4 per ton in 1909.

The cost of producing magnesite differs considerably in different counties, owing to the diverse character of the deposits and the differences in the cost of carrying it to the nearest railroad. In some localities the ore is valued as low as $2.35 per ton at the mines; in others as high as $9 per ton. Where the merchantable ore occurs in small stringers, instead of in heavy homogeneous deposits, the cost of production is much increased. Moreover, where considerable development work is combined with that involving the extraction of ore, the cost increases, and it is not always feasible so to segregate the two factors of cost as to fix an exact valuation on the ore mined ready for sale. The price given is that at the railroad station nearest the respective mines.

Only seven mines in California were productive in 1909, and all but two of these are small, yielding a few hundred tons each. These mines are in Fresno, Napa, Riverside, Santa Clara, and Tulare counties, the most productive one being in Tulare County. The sale of the product of these mines is virtually limited to localities on the Pacific coast, the cost of transportation to points of consumption east of the Rocky Mountains being prohibitive. The California magnesite can not compete in price at eastern points with that imported from Greece and Hungary, whence shipments are made by sea and where cheap labor conditions prevail.

Most of the magnesite produced in California is used in the manufacture of paper from wood pulp in the paper mills of California and Oregon. The quantity used for making artificial stone and tile and flooring and building material is increasing each year. For these purposes and in paper manufacturing, only calcined magnesite is used. Crude magnesite is used only in manufacturing carbonic-acid gas, in the course of which process the magnesite is calcined and then is sold in that form. This calcined magnesite is sold generally at from $16 to $20 per ton, and it takes about 2 tons of crude ore to make 1 ton of the calcined material.

The few new mines opened in 1909 were small, none of great importance having been developed to a producing stage. The county most productive in magnesite is Tulare, which has three mines, one of them the most important in the State. On this property calcining furnaces have been installed for some time, and the entire output is calcined before shipment. The other two mines in the county are not equipped for calcining the crude ore. The Fresno County mine has a calcining kiln with a capacity of 20 tons per day. The mine in Riverside County is also equipped with a calcining plant. The Santa Clara County mine shipped its crude ore to a factory where it was calcined for use as artificial marble, flooring, building material, etc. The Napa County mine is not provided with calcining furnaces. None of the Sonoma County deposits were worked during 1909, and several other known deposits in other counties were also idle during that year.

The following table shows the quantity and value of the domestic output from 1891 to 1909, inclusive:

Quantity and value of crude magnesite produced in the United States, 1891–1909.

1891	short tons	439	$4,390	1901	short tons	3,500	$10,500
1892	do	1,004	10,040	1902	do	2,830	8,490
1893	do	704	7,040	1903	do	3,744	10,595
1894	do	1,440	10,240	1904	do	2,850	9,298
1895	do	2,220	17,000	1905	do	3,933	15,221
1896	do	1,500	11,000	1906	do	7,805	23,415
1897	do	1,143	13,671	1907	do	7,561	22,683
1898	do	1,263	19,075	1908	do	6,587	19,761
1899	do	1,280	18,480	1909	do	9,465	37,860
1900	do	2,252	19,333				

IMPORTS.

Both crude and calcined magnesite are annually imported into the United States in large quantities. In 1909 the quantity of crude imported was 19,635,479 pounds, valued at $46,005, or $4.69 per short ton, and of calcined but not purified 208,947,602 pounds, valued at $939,014, or $8.99 per short ton. The quantity of crude magnesite imported is decreasing, and the imports of calcined appear to be increasing gradually. The prices quoted are the wholesale prices of the material when ready for shipment in the foreign countries, and if cases, crates, etc., are used their cost is included in the value given, but these values do not include freight or any other charges incurred after shipment.

The imports of magnesite into the United States in 1908 and 1909 were as follows:

Imports of magnesite and magnesia into the United States in 1908 and 1909, in pounds.

	1908.		1909.	
	Quantity.	Value.	Quantity.	Value.
Magnesia:				
Calcined, medical	46,823	$7,451	52,247	$8,697
Carbonate of, medical	62,514	3,475	49,115	3,328
Sulphate of, or Epsom salts	4,990,875	15,543	6,612,956	28,180
Magnesite:				
Calcined, not purified	129,462,109	655,245	208,947,602	939,014
Crude	39,526,865	81,518	19,635,479	46,005

In addition, magnesium not made up was imported to the value of $16,194 in 1909, as compared with a value of $12,410 in 1908. The total value of the imports of magnesia and magnesite in 1909 was $1,041,418, as compared with $775,642 in 1908. The most notable feature of the table is the increase of 79,485,493 pounds in quantity and of $283,769 in value in the imports of calcined magnesite in 1909 as compared with 1908. In 1907 the quantity of calcined magnesite reported was 151,137,661 pounds, valued at $688,371. These imports were mainly from Greece and Hungary, and the prices at which the substance may be laid down in New York precludes the possibility of the California product competing in that market under present conditions. For this reason it is not probable that there will be any material increase in annual product from the California mines, at least until the Panama Canal is completed, when magnesite may be shipped by sea from the Pacific to the Atlantic coast.

The uses to which magnesite may be put were given in full in the report for 1907 and were also published in Survey Bulletin 355.[a]

[a] Hess, Frank L., Magnesite deposits of California: Bull. U. S. Geol. Survey No. 355, 1908.

MICA.

By Douglas B. Sterrett.

INTRODUCTION.

Two varieties of mica have been used extensively in manufacturing industries—muscovite, or "white" mica, and phlogopite, or "amber" mica. A third variety, biotite, a black to dark-brown mica, has recently been used in very small quantities. Some phlogopite is also very dark colored, nearly black, and hard to distinguish from biotite, as might be expected, for the two varieties belong to a group in which there are gradations from one to the other in both chemical and physical properties. Muscovite is a silicate of alumina and potash; biotite and phlogopite are ferromagnesian silicates, containing a variable percentage of potash. The three micas are very similar in physical properties other than color. Each has strongly developed cleavage, so that it may be split into exceedingly thin sheets, which are highly flexible and elastic. Its flexibility and elasticity, combined with the fact that it is a nonconductor of both heat and electricity, render mica particularly useful for industrial purposes. The sheets can be trimmed and bent into a variety of forms for application to the uses required of them. Muscovite can be used in places where it is to be exposed to heat and where it is also desirable to allow light to be transmitted. The inherent properties of mica do not greatly vary, but the perfection of the crystallization and the size of the crystals and the extent to which they have resisted natural agencies of destruction in the earth determine the industrial value of the mined product.

OCCURRENCE.

Muscovite is the principal mica mined in the United States, though small quantities of biotites have been produced from some of the same mines that yield the muscovite. No phlogopite or "amber" mica is mined commercially in the United States; the world's supply of phlogopite mica comes principally from Canada. Muscovite and the biotite mica sometimes associated with it occur in pegmatite rocks. Pegmatite is composed of the same minerals as granite, but in varying and sometimes quite different proportions. In some pegmatite deposits either quartz or feldspar is the predominant mineral, and in a few deposits mica composes the bulk of the pegmatite.

Mica-bearing pegmatite is commonly found in metamorphic crystalline rocks, such as mica or garnet gneiss or schist, cyanite schist, hornblende schist, and granite gneiss. The deposits occur as sheets, lenses, and irregular masses, having variable relations to the wall rocks. In metamorphic bedded rocks the "veins" often, through part or all of their extent, lie parallel to the schistosity or banding. Some "veins" cut across the bedding at an angle.

The occurrence of mica in the pegmatite is not regular. The pegmatite may be rich in mica in one portion and almost barren in another. There may be leads or streaks of mica blocks or only isolated crystals irregularly distributed through the "vein," or the mica may occur scattered more or less regularly through the mass. The rich pegmatite veins worked for mica range in thickness from 1 foot to over 50 feet. The distance to which the mica content is sufficiently rich to work may be only a few feet or it may be several hundred feet.

NORTH CAROLINA.

The mica mines of North Carolina are located in three belts—one in the mountain region northwest of the Blue Ridge, another along the Blue Ridge, and the third in the Piedmont Plateau southeast of the Blue Ridge. The deposits in the mountain and the Piedmont Plateau regions generally contain better mica than those in the Blue Ridge region. The principal mining for some years past has been in the mountain region in Macon, Jackson, Transylvania, Haywood, Yancey, Mitchell, and Ashe counties. A large part of the production comes from many mines and prospects that are worked in a small and more or less desultory way. A few mines, operated on a larger scale, are equipped with steam pumps, hoists, and air drills.

The crude mica is sold in part in the rough, as crystals or blocks, at the mines, in part it is split and rough trimmed and graded according to the size and quality of the sheets before selling. Some of the larger dealers who both work mines and manufacture the mica split and rough trim the mica at the mines; others do all the manufacturing at their main plants.

The plant of the Great Southern Mica Company was moved from Heflin, Ala., to Asheville, N. C., in order to be nearer a larger available supply of mica. During some years nearly a hundred mica mines and prospects are in operation in North Carolina, and Asheville is practically a central location for all of them. The Great Southern Mica Company purchases rough and rough-trimmed mica in several counties and turns out stove and electric sheet mica, punch mica, and ground mica. The plant is equipped with 16 power punches and 3 hand punches for manufacturing punch mica. Grinding is done with a Raymond pulverizer, which has a capacity of 12 tons of ground mica a day. The sizing capacity of the plant is not equal to the capacity of the pulverizer. The pulverizer grinds the mica dry, the beater revolving at the rate of 2,900 revolutions a minute. Part of the ground mica in which exact equality of size is not necessary is sized by air draft. The remainder is graded by hoppers with sizing screens. The ground mica is drawn by air draft from the pulverizer, part going to the air-draft sizer and part to the hopper. Some flake mica with scales as coarse as one-fourth inch in diameter is sold. The manufacturers of roofing material in the Middle West take a large part of the output of ground mica. The plant uses electrical power supplied from the city power mains. A switch from the Southern Railway tracks runs over a trestle to the second floor of the building, where the mica is unloaded from the cars into storage bins. A chute feeds from this floor to the pulverizer below.

Of other large companies handling mica in North Carolina, some manufacture either sheet, punch, or ground mica, and others two or more of these products. The plants manufacturing sheet and punch mica generally sell their waste or scrap mica to grinding plants. The latter also purchase considerable small rough blocks and sheets for grinding directly from the mines. Most of the manufacturers of ground mica use the wet-grinding method. This is a much slower operation than dry grinding, but the product is claimed to be cleaner and more lustrous, and therefore better adapted to decorative purposes. Three of the wet-grinding mica plants are located at or near Plumtree, in Mitchell County. These are the mills of the Burleson Brothers, D. T. Vance, and T. B. Vance. One of the larger wet-grinding mills is that of the Penland Mica Mills Company, at Penland, also in Mitchell County. This mill has not been operated continuously.

Nearly all of the larger companies dealing in mica produce both sheet and punch mica. Both hand and power punches are used. The demand for large quantities of punch mica in electrical apparatus furnishes a profitable way of disposing of small-sized sheet mica and trimmings from large sheets. The waste from cutting sheet and punch mica is the best for grinding, as foreign minerals have been removed in splitting the mica to the proper thickness for cutting into sheets.

The Asheville Mica Company, of Asheville, produces both sheet and punch mica. The scrap and waste mica is sold to the grinding mills. This company's plant is equipped with 16 power punches, which are equipped with dies to punch disks, washers, and a variety of odd-shaped patterns. During 1909 the Asheville Mica Company conducted a trial to determine the practicability of thin splitting mica in North Carolina. From 10 to 12 young women were employed for a period of several months. The work was profitable until the price of the India mica splittings declined about 5 cents a pound. The young women were paid from 9 to 12 cents a pound and were able to make from 75 cents to $1 a day. North Carolina mica was used, and the product was considered good by the mica plate manufacturers. The mica was not, on an average, split quite so thin or so evenly as India mica, but it is probable that it could be split thinner as the operators gain greater experience. Whether the industry could be carried on profitably is largely a question of competition with the thin splittings from India.

The J. E. Burleson Company, of Spruce Pine, operated five of its mica mines during part or all of 1909. These mines were the Walnut Knob mine, in Ashe County; the George's Fork mine, the Cattail mine, and the Poll Hill mine, in Yancey County; and the Stinchcombe mine, near Booneford, Mitchell County. The Burleson Company manufactures both sheet and punch mica and disposes of the scrap mica to local grinding mills.

IDAHO.

Deposits of mica have been found in several counties in Idaho. Those in Latah County, near Avon, have received the most attention, and one or two of them have yielded large quantities of mica. These deposits lie in a north-south belt, about 2 miles wide and several miles long. The mines and prospects examined are from 3 to 6 miles north of Avon. They are in T. 41 N., R. 2 W., and lie, at elevations of 3,400 to 4,700 feet above sea level, along the top and to the west of a high mountain ridge extending south from the Thatuna Hills. The principal properties are the Muscovite claim of Alexander Munro, about 5½ miles north of Avon, in sec. 2; the Levi Anderson mine, about 4 miles north of Avon, in sec. 22; the Maybe mine of Alexander Munro, about 1 mile west of south of the Muscovite claim, in sec. 22; the Luella mine of the Western Mica Company, about 1½ miles southwest of the Muscovite, in sec. 21. Other claims are owned by Alexander Munro and David Peterson, in sec. 15. In order from south to north along the ridge the mines are: The Levi Anderson mine, the Muscovite, Atlas, Violet, and Morning Star claims of Alexander Munro, and the Sunshine claim of David Peterson. The Maybe and the Luella mines are in the valley to the west of this ridge. At the time of the writer's visit (June, 1910), the Muscovite was the only mine in operation; it had been idle a few years and was being cleaned out preparatory to mining. The elevations given were determined by barometric measurement and the directions are magnetic. The variation is about 22° east of north.

The Levi Anderson mine is in a low rounded knob on the ridge at an elevation of about 4,100 feet. The main opening is on the east side near the top, and a second opening has been made about 200 yards to the north at a lower level. The main working consists of an open cut about 20 feet wide, 30 feet long, and 15 feet deep, with short tunnels to the north and to the south and an incline from the bottom. The workings have fallen in badly. As exposed in the open cut the pegmatite is about 20 feet wide and approximately conformable with the inclosing rock. The country rock is mica schist and gneiss, with a strike of N. 30° W. and a dip of 60° SW. The pegmatite carries a large amount of quartz with some black tourmaline and beryl crystals. Only small-sized crystals and sheets of mica were seen around the mine; mica in sheets of valuable size was seen in the possession of Mr. Anderson at Spokane. At the other working a shaft was sunk on a pegmatite ledge. Only small mica was left around this opening also. Part of the muscovite had biotite associated and intergrown with it.

The Muscovite mine was first worked in 1888 by Woody & Lamb. After that it was operated intermittently, the last work being by the Muscovite Mica Company, of Spokane. The mine then passed into the hands of Alexander Munro, of Moscow, Idaho, the present owner. The " vein " in the Muscovite mine cuts through the apex of a sharp knob whose elevation is 4,450 feet. An open cut with a shaft has been made on the outcrop at the apex, and other open cuts with drifts and a 60-foot shaft to the south on the hillside. The principal work was done from two crosscut tunnels with drifts and stopes at the ends; one of these was 150 feet lower than the apex and on the east side of the hill; the other was on the west side of the knob and 200 feet lower than the apex—this was the only part of the mine open (June, 1910) for examination. Another crosscut tunnel was started still farther down, about 325 feet below the apex; this has been driven about half of the 600 feet necessary to reach the " vein." Other test pits have been made nearly one-quarter of a mile south of the apex on a pegmatite outcrop which may or may not be the same "vein." The tunnel open for examination had been driven some 200 feet to the "vein." Over 300 feet of drifts, with a large amount of stoping above them, were then carried to the north. At the junction of the tunnel and the drift at this level a room for a turntable had been made during previous operations. The timbers of the roof over this turntable and of the stopes in places farther along had given way so that, in order to reach the better part of the mine, it was necessary to drive a new tunnel alongside of the main original drift. The 60-foot shaft formerly connected with the drift at the end of the crosscut tunnel. A short crosscut tunnel to the west of the new drift cut a pegmatite "vein," from 12 to 18 inches thick, in which small blocks of good mica and some beryl crystals were found.

The main pegmatite "vein" ranges in thickness from 4 to 6 feet in the main original drift and the stopes above and widens out to 12 feet thick at the end of the drift, where the vein includes a horse of gneiss several feet across. There was a large showing of mica "books," some of good size, in the end of the tunnel and at two places seen in the stopes above. It is said the best mica in sight was removed when the mining was stopped, though even then the "vein" contained sufficient mica to be termed rich. In the open cut at the apex the pegmatite mass encountered appears to be nearly 40 feet thick. The pegmatite at this point and to the side of the open cut carries considerable quartz. A portion that had not been mined still contains numerous blocks of fair-sized mica on the outcrop.

The country rock is muscovite biotite gneiss strongly foliated. It has a strike of N. 10° to 30° W. and dips about 70° W. The pegmatite is conformable, or nearly so, with the gneiss. The course of the pegmatite is fairly regular, but a few minor deformations were encountered in the workings. Evidently the outcrop at the apex represents a large bulge or swelling of the pegmatite. The increasing thickness of the pegmatite in the end of the drift 200 feet lower indicates a continued thickness with depth. This drift probably does not lack more than 60 or 70 feet of being under the apex. This chimney or shoot of pegmatite outcropping at the apex is considered to be the richest part of the "vein." In the tunnel on the east, 150 feet lower than the apex, a large vein very rich in mica is reported to have been encountered. A peculiar feature of this "vein" is the small amount of quartz and feldspar it contains at a distance from the apex chimney. In the chimney the quartz and feldspar are plentiful and the pegmatite is more nearly normal in composition. The production of mica from this mine has been large. No records have been kept, but Mr. Munro estimates that during two periods of operation in the past at least $40,000 worth of mica was taken out each time. The quality of the sheet mica from the Muscovite is very good, the color being light "rum" and the sheets clear. It is probable that the proportion of good sheet mica obtained from an average lot of books would not equal that of some of the better mines in other parts of the country, though there are probably few mines that will yield so abundantly from an equal amount of vein matter as the Muscovite mine.

The two claims taken up by Alexander Munro extending to the north from the Muscovite are intended to cover the outcrop of the pegmatite between the Muscovite and the Morning Star, at which point the outcrop is strong. On the latter claim the pegmatite outcrops strongly for some distance along the east side of the ridge. The hill slope below is steep, almost cliff-like in places. The pegmatite is about 20 feet thick and incloses a horse of gneiss, or there are two ledges of pegmatite separated by a sheet of gneiss. The ledge is conformable with the mica schist country rock and strikes about north with a dip of about 60° W. Both the schist and the pegmatite contain black tourmaline. The showing for mica in the outcrop of this ledge is small. At a level of about 450 feet lower a crosscut tunnel was started on the east side of the ridge and driven 660 feet under the outcrop. The dip of the pegmatite carries it still farther west and the tunnel will probably have to be carried 90 feet farther. The rock through which the tunnel cuts is muscovite biotite schist gneiss, with a slight banding in places across the foliation. The schistosity strikes west of north and dips 50° to 70° W.

The Sunshine claim adjoins the Morning Star on the north. The pegmatite ledge outcrops strongly on the hillside and is probably the same ledge as that opened on the Morning Star. An open cut 20 feet long and 10 feet deep has been made in the hillside on a pegmatite body striking north with a dip of 50° W. It is conformable with the inclosing schist gneiss. Very little mica was found in this cut. The pegmatite carries tourmaline and also garnets larger than walnuts. It is said that a better showing for mica was found in a prospect opened about 200 yards to the north over the hill.

The Maybe mine, sometimes called the Silver White mine, is in a steep hillside in the bend of a stream. Several tunnels have been run into the hill and a few pits and other openings made. These have caved in so badly that little could be seen. Either there are two or more ledges of pegmatite, or a single ledge is folded and lies somewhat like a blanket on the hillside. In one of the openings the mica schist country rock has a strike of N. 75° W., about parallel with the contour of the hill at that point. The pegmatite carries considerable tourmaline and some garnets up to walnut size. The mica is clear and of a very light color, inclining to "rum." Judged by the waste mica left around the mine, the sheets are of good quality and split well.

On the hillside, across the small stream to the east of the Maybe mine, several prospects for mica have been operated. This work is old, though the indications for mica are good. A few hundred yards southwest of the Maybe mine near the corner of the claim another pegmatite body was prospected for mica. A very good deposit of mica was found in the open cut; a tunnel started 15 feet lower down very quickly lost the main "vein" and followed a stringer for nearly 300 feet.

The Luella mine was opened by a crosscut tunnel, run in a southwest direction, and an open cut on the outcrop above it. Evidently a large pegmatite deposit was found and much of it stoped out. Only small mica, though of good quality, was left around the mine. The pegmatite blocks on the dump contain black tourmaline and pink garnet. The latter are embedded in mica crystals in some cases. The country rock is muscovite biotite schist gneiss. Blocks of fine-banded tourmaline quartz rock, associated with the schist gneiss, were left on the dump.

The operation of mines in this region is facilitated by an abundant supply of good timber. Part of this timber is included on the claims and part is either on State or reserve land. On the mountains the important trees are tamarack or larch and red fir; in the valleys there are good stands of white pine, red pine, tamarack, red fir, and cedar.

The mica deposits described occur in an area of metamorphic rock, which is highly schistose and in places has a banded gneissic structure. The principal constituents of this rock are muscovite and biotite mica and quartz. The schistosity of the rocks in this region strikes principally north and south or northwest and southeast, and dips to the west at angles ranging from 50° to vertical. The pegmatite bodies are in general comformable with the inclosing rock, though locally they cut the schistosity of the latter. The pegmatite is apparently more plentiful in the rock at lower elevations in the valley to the west of the high mountain ridge than in the ridge. It is claimed that the mines along the top of the mountain are on the same ledge of pegmatite. This may be true or there may be separate sheets that do not connect, though nearly in line with or overlapping one another. Even if the pegmatite bodies are so persistent in extension, their mica content is more variable.

MARYLAND.

In consequence of inquiries received at the Survey three mica deposits were examined near Laurel, Md. Two of these are close together and are about 6 miles N. 35° W. of Laurel, in Howard County. The other deposit is 4 miles N. 70° W. of Laurel, in Montgomery County. The first two deposits are on the land of Charles Myers, 2 miles north of Scaggsville. One of them has recently been prospected by William Theis, of Ellicott City, Md. The work consists of an open cut, 20 feet long and 2 to 8 feet deep, extending north into a hillside along a pegmatite ledge, and a second cut started 50 feet to the northeast to crosscut the "vein." The pegmatite strikes about north and outcrops some 30 feet farther up the hill above the open cut. The dip could not be measured. The country rock is mica gneiss, with highly schistose layers. The pegmatite contains considerable quartz, part of which though smoky is rather clear. The feldspar is flesh colored and is partly decomposed. Mica occurs in blocks or crystals up to 50 pounds in weight and 1 foot in diameter. This mica has a brownish-green color and much of it is "specked." Most of the crystals have the "A" structure strongly developed, so that only small perfect sheets can be cut from large blocks. "Wedge"-shaped blocks of mica occur, especially where the smaller crystals are bunched with quartz. Some of the larger blocks of mica would cut sheets 4 by 6 inches, though there would be a large amount of waste in trimming.

The second mica deposit on the Myers land is in a steep knoll about 150 yards southwest of the first prospect. It is said that this second prospect was opened about twenty-seven years ago by a shaft 45 feet deep. At present there is on the summit of the knoll a shallow pit or sink some 20 feet across and 3 feet deep. The ground in and around this sink is covered with scrap mica and earth to a depth of a few feet. The mica plates range up to 6 inches across and some are firm and clean enough for cutting into small sheets and for punching. The pegmatite may occur in a short, thick body or chimney outcropping at the summit of the knoll, though there are indications that it has an easterly extension downhill. The mica has a light, clear, apple-green color, in sheets of one-sixteenth of an inch or more in thickness. It splits to the best quality of "white" mica for stove purposes. The waste and scrap still around the prospect should furnish a good grade for grinding for wall-paper decoration.

The third mica locality visited is on the land of James E. Broadhurst, about 1½ miles northeast of Burtonsville. No work has been done on this deposit, but promising specimens have been obtained from the surface. At a point about 100 yards southwest of the house plates of mica from 1 to 5 inches across have been plowed up on the surface of a field. Mica scales up to 2 inches across are scattered through the soil for a distance of 75 yards farther southwest. At one point in this band of mica scales a few large blocks of massive white quartz outcrop. Small blocks of pegmatite with flesh-colored feldspar are also associated with the mica in the field.

Sheets of mica 3 or 4 inches across have been found loose in the soil at another point about 75 yards southwest of the house. Blocks of pegmatite and mica gneiss are associated with them.

About one-third of a mile north of the house sheets of mica several inches across have been found loose in the surface soil on the outcrop of a pegmatite mass. The large blocks of pegmatite on the hillside at this point contain numerous small plates of mica. There are also blocks of pinkish-gray or flesh-colored feldspar several inches across with masses of white quartz. This pegmatite appears to have a strike a little east of north, though it may be a short thick body. The mica schist country rock in the vicinity is highly crumpled and contorted, though its general course is east of north.

On the land adjoining the Broadhurst farm on the west, large quantities of mica scales are mixed through the soil along a hillside. The largest of these scales are 2 inches or more in diameter.

The mica from these prospects has a light apple-green color and splits well. Only partly weathered surface mica was examined. The quality is excellent and would be suitable for glazing purposes if obtained in larger sheets.

The country rock of the region in which these mica prospects are located consists of mica schist and gneiss with garnetiferous phases. The schists and gneisses are badly crumpled and folded in places and are injected by pegmatite. They weather down to highly micaceous soils. In character they appear to be identical with the rocks of the Carolina gneiss as mapped by Keith.[a] These rocks are mapped as the Baltimore gneiss by the Maryland Geological Survey.[b]

NEW MEXICO.

The occurrence of mica in northern central New Mexico, especially in Taos County, has been known for several years. A new deposit has been reported in San Miguel County, about 20 miles south of Las Vegas, in the Glorietta Mountains. This deposit has been taken up

[a] Washington folio (No. 70), Geol. Atlas U. S., U. S. Geol. Survey, 1900.
[b] Clark, Wm. B., Geological map of Maryland: 1907. Maryland Geol. Survey.

by the Anderson Mica Company, of Topeka, Kans. The company reports active development of the mines and expects to equip a factory for manufacturing the mica in Topeka. Mr. H. S. Anderson, president of the company, kindly sent a specimen to the Survey for examination. This specimen measured 8 by 12 inches. It was somewhat "ruled" and marred by other lines of fracture and contained very thin light iron "specks." Portions of this specimen of mica split perfectly and would yield sheets 3 or 4 inches square suitable for electrical purposes.

NEW YORK.

A deposit of muscovite mica was operated in St. Lawrence County during part of 1909 and 1910 by Henry Brewster, of Syracuse, N. Y. The mine is about 1½ miles from Oswegatchie, on the main highway to the village of Fine, on the north side of Oswegatchie River. Mr. Brewster states that the work during the fall of 1909 consisted of an open cut 8 feet wide and 20 feet deep. Mica is obtained in crystals measuring up to 6 or 8 inches across.

SOUTH CAROLINA.

Several mica mines have been opened in the Greenville region, in South Carolina, from some of which good mica has been obtained in quantity. Two of these were operated during 1907 and then left idle. Mr. George L. English, of Shelby, N. C., has advised the writer of more recent work on one of these deposits, the R. C. Willimon mine, 8 miles south of Greenville. It is reported that a considerable sum of money was spent on this mine during 1909 and that a quantity of rough mica was shipped. A shaft has been sunk 77 feet and a drift over 150 feet long run from it.

USES.

Mica is used in large quantities in both sheet and ground form. Sheet mica is used in stoves, gas lamp chimneys, lamp shades, for glazing purposes, and in many kinds of electrical apparatus and machinery. The electrical industry consumes by far the greater part of the sheet mica produced. The mica serves as a perfect insulator in various parts of dynamos, motors, induction apparatus using high voltage, switchboards, lamp sockets, etc. The domestic mica is satisfactory for all insulation except for commutators of direct-current motors and for dynamos built up of bars of copper and strips of mica. For this purpose no mica is as satisfactory as the phlogopite or "amber" mica. This mica is of about the same hardness as the copper of the commutator segments, and therefore wears down evenly without causing the motor to spark. A large quantity of the small sheet mica used in electrical apparatus is built up into micanite or mica board, the thin sheets being built up layer after layer with shellac, with or without tissue paper, and then subjected to great pressure, with heat to dry out the shellac.

Scrap mica, or mica too small to cut into sheets, and the waste from the manufacture of sheet mica are used in large quantities commercially. The greater part is ground for the manufacture of wall papers, lubricants, fancy paints, and molded mica for electrical insulation. Ground mica applied to wall papers gives them a silvery luster. When mixed with grease or oils mica forms an excellent lubricant for axles and bearings. Mixed with shellac or special compositions, ground mica is molded into desired forms and is used in insulators. Ground mica so used should be free from metallic minerals. Mica used for lubrication should be free from gritty matter; for this use only pure mica should be ground, or the grit should be eliminated after grinding. For wall papers and brocade paints a ground mica with a high luster is required, and such luster is best obtained by using a clean light-colored mica and grinding it under water. Coarsely ground or bran mica is used to coat the surface of composition roofing material.

PRODUCTION.

The total value of the mica produced in the United States in 1909 amounted to $280,529. The production came from nine States—North Carolina, South Dakota, New Hampshire, Virginia, Colorado, Alabama, New York, Georgia, and Maine—named in the order of the value of their output. No production was reported from New Mexico and South Carolina during 1909, though these States contributed to the production of 1908. New York entered the list of mica-producing States in 1909 with one producer. The value of the production of mica in 1909 was greater by $12,604 than in 1908, though less by $111,582 than in 1907.

The production of sheet mica amounted to 1,809,582 pounds, valued at $234,482, an increase of 836,618 pounds in quantity and of $461 in value as compared with the output of 1908. The large increase in quantity without a corresponding increase in value of production is due to several causes—among them being an increased production of small-sized sheet and punch mica and a reduction in the price of mica because of the lower tariff.

The production of scrap mica amounted to 4,090 short tons, valued at $46,047, an increase of 1,673 tons in quantity and of $12,143 in value, as compared with the figures for 1908.

The value of the production of mica in North Carolina in 1909 was $148,424, as compared with $127,870 in 1908, an increase of $20,554. The production in 1909 consisted of 1,296,274 pounds, valued at $122,246, and 2,607 short tons, valued at $26,178. The output came from Macon, Mitchell, Yancey, Jackson, Transylvania, and Ashe counties. The value of the production of mica in New Hampshire in 1909 was $16,180, representing 55,808 pounds of sheet mica, valued at $12,086, and 412 short tons of scrap mica, valued at $4,094. The output of mica in the remaining States is not given separately, since there are only one or two producers in each State.

The production of mica in the United States since 1880 is given in the following table:

Production of mica in the United States, 1880-1909.

Years.	Sheet mica.		Scrap mica.		Total value.
	Quantity.	Value.	Quantity.	Value.	
	Pounds.		*Short tons.*		
1880	81,669	$127,825	....	....	$127,825
1881	100,000	250,000	....	....	250,000
1882	100,000	250,000	....	....	250,000
1883	114,000	285,000	....	....	285,000
1884	147,410	368,525	....	....	368,525
1885	92,000	161,000	....	....	161,000
1886	40,000	70,000	....	....	70,000
1887	70,000	142,250	....	....	142,250
1888	48,000	70,000	....	....	70,000
1889	49,500	50,000	....	....	50,000
1890	60,000	75,000	....	....	75,000
1891	75,000	100,000	....	....	100,000
1892	75,000	100,000	....	....	100,000
1893	51,111	....	156	....	88,929
1894	35,943	....	191	....	52,388
1895	44,325	....	148	....	55,831
1896	49,156	65,441	222	$1,750	67,191
1897	82,676	80,774	740	14,452	95,226
1898	129,520	103,534	3,999	27,564	131,098
1899	108,570	70,587	1,505	50,878	121,465
1900	456,283	92,758	5,497	55,202	147,960
1901	360,060	98,859	2,171	19,719	118,578
1902	373,266	83,843	1,400	35,006	118,849
1903	619,600	118,088	1,659	25,040	143,128
1904	668,358	109,462	1,096	10,854	120,316
1905	924,875	160,732	1,126	17,856	178,588
1906	1,423,100	252,248	1,489	22,742	274,990
1907	1,060,182	349,311	3,025	42,800	392,111
1908	972,964	234,021	2,417	33,904	267,925
1909	1,809,582	234,482	4,090	46,047	280,529

PRICES.

The average price of sheet mica in the United States during 1909, as deduced from the total production, was 12.9 cents per pound, as compared with 24.1 cents per pound in 1908. The average prices per pound of sheet mica as reported in the production from several States were as follows: North Carolina, 9.4 cents; South Dakota, 21.4 cents; New Hampshire, 21.6 cents; Virginia, 50.1 cents; Alabama, 25 cents; New York, 19.2 cents; Georgia, 5 cents. The average price of scrap mica, as deduced from the total production, was $11.26 per ton, as compared with $14.02 in 1908 and with $14.14 in 1907. The price of scrap mica in North Carolina was a little over $10 per ton; in South Dakota, $16.71; in New Hampshire, $9.93; in Colorado, $13.

The prices of selected manufactured sheet mica for use in stoves ranged from 75 cents per pound for sheets measuring 2 by 2 inches to $7 per pound for sheets measuring 6 by 8 inches.

IMPORTS.

The imports of unmanufactured and trimmed sheet mica into the United States during 1909, as reported by the Bureau of Statistics of the Department of Commerce and Labor, amounted to 1,846,651 pounds, valued at $618,813. This is more than three times as much as the imports for 1908 in quantity and nearly two and one-third times as much in value. The imports were not as great in 1909, however, as in either 1906 or 1907.

The quantity and value of mica imported into the United States annually from 1904 to 1909, inclusive, are shown in the following table:

Mica imported and entered for consumption in the United States, 1904–1909, in pounds.

Year.	Unmanufactured.		Cut or trimmed.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1904	1,085,343	$241,051	61,986	$22,663	1,147,329	$263,714
1905	1,506,382	352,475	88,188	51,281	1,594,570	403,756
1906	2,984,719	983,981	82,019	58,627	3,066,738	1,042,608
1907	2,226,460	848,098	112,230	77,161	2,338,690	925,259
1908	497,332	224,456	51,041	41,602	548,373	266,058
1909	1,678,482	533,218	168,169	85,595	1,846,651	618,813

The larger imports of mica should probably be interpreted as a return to more normal conditions of demand by the manufacturing industries than as due to the reduction of import duties. Under the new law rough mica is dutiable at 5 cents per pound and 20 per cent ad valorem, and manufactured mica at 10 cents per pound and 20 per cent ad valorem. This is a reduction of 1 cent per pound for rough and of 2 cents per pound for manufactured mica.

FOREIGN PRODUCTION.

INDIA.

The exports of mica from India[a] in 1908 amounted to 27,572 hundredweight, valued at £139,513, as compared with 39,055 hundredweight, valued at £226,382 in 1907. The quantity of mica exported in 1908 was but little over one-half as great during 1906.

CANADA.

The production of mica in Canada[b] during 1909 was valued at $154,106. This was a slight increase over the value of the production during 1908 according to the revised figures of 436 tons of mica valued at $139,871. The exports of mica during 1909 amounted to 717,066 pounds, valued at $256,834, as compared with 580,195 pounds, valued at $198,839 in 1908.

[a] Rec. Geol. Survey of India, vol. 38, pt. 1, 1909.
[b] Preliminary report on the mineral production of Canada in 1909, Dept. Mines. Canada.
Canada.

MINERAL WATERS.

By Samuel Sanford.

SCOPE OF STATISTICS.

In the statistics presented in this report the same distinctions are made as in the reports of mineral-water production for 1906, 1907, and 1908. The statistics include neither everything classed as mineral water in the trade nor only the natural spring waters sold for medicinal purposes. In distinguishing between what to include and what to exclude a somewhat arbitrary rule was necessary because of the great variety of natural waters, the widely different methods by which they are prepared for market, the many purposes for which they are sold, and of the gradations between strictly natural and strictly artificial waters. In general, the decision was based on commercial rather than scientific grounds, so that although the figures of output include waters that differ widely in mineralization they do not include any water sold for public supply nor any that is essentially artificial. Hence the statistics cover the output of both natural waters, those bottled just as they flow from spring or well, and of what may be called seminatural waters; that is, natural waters that have been strenthened by evaporation, treated to prevent the deposition of iron, or carbonated by gas obtained from the spring or well or by gas made artificially. Both the natural and the seminatural waters fall into two classes, table and medicinal.

The waters excluded from the tables given in this report are of many kinds. They comprise the strictly artificial drinks, both the artificial vichy and seltzer and other artificial table waters and the various proprietary remedies that may be called medicinal waters; all water distributed by public supply systems; and all water furnished free or at a nominal charge to guests at hotels and sanitariums for drinking or bathing. The sweetened beverages or soft drinks are not classed as mineral waters and are of course excluded.

DEFINITION OF MINERAL WATER.

The preceding statement indicates the meaning attached to the term "mineral water" in this report. The term is used in a commercial way, that is, a mineral water is defined as any natural or seminatural water sold in bulk or in packages. The most essential feature of this definition is that the water must be sold—must be an article of commerce; the next feature in importance is the degree to which the natural quality of the water has been charged prior to marketing. The actual mineralization of a water, whether high or low, the owner's opinion of its therapeutic value or lack of mineral content, the purpose for which the water is sold or the manner in which it is marketed are matters that have nothing to do with determining what is to be styled mineral water in this report.

TABLE AND MEDICINAL WATERS.

The plan of reporting in separate totals the output and the value of table and of mineral waters in the statements of production by States, was first used in the report for 1905, and has been followed with slight modification in the succeeding reports. Necessarily, no sharp line can be drawn between the two classes. Waters so mineralized that they would be classed as mineral in one section of a State are used for ordinary domestic purposes in another, and many moderately or slightly mineralized waters that are sold for table use are prescribed by physicians in the treatment of disease and so can be said to have thereapeutic value. In general, however, the table waters are less mineralized than those sold for medicinal use. The latter vary greatly in the total substances they contain and in the proportion of the substances in solution, but may be roughly grouped in three classes, purgative, "lithia," and sulphur waters.

The first class includes many of the most widely advertised medicinal waters on the market. These waters for the most part contain a high percentage of sulphates with much magnesium or sodium or both. Chemists believe that these substances may be combined in the form of sodium sulphate (Glauber's salts), magnesium sulphate (Epsom salts), and it is to these salts, singly or together, that the waters owe their distinctive properties.

The "lithia" waters are extensively sold, but owe their vogue largely to advertising; all of them contain lithium, but in most of them this element is present in such small quantities that the exact effects of the element on the human body and even the precise chemical combination it makes with the acid radicles in solution in the water are not at all certain. Salts of lithium are supposed to form with uric acid soluble compounds readily eliminated by the human system, hence "lithia" waters have been advocated for all forms of uric acid diathesis. The present tendency among physicians and physiologists, however, is to regard the lithia salts as diuretics rather than as uric acid solvents. Certainly the quantity of lithium, combined in the form of carbonate, bicarbonate, or chloride, in some "lithia" waters is so very small that its therapeutic value must be slight if not negligible; and such waters have no more medicinal value than other light and agreeable table waters. The cures attributed to such waters must be attributed to copious use quite as much as to the distinctive physiologic action of some lithia compound.

In the third class come the great array of waters drunk at the various sulphur springs. They are little sold in bottles, hence they do not figure largely in the statistics given in this report, but the total quantity annually consumed is very large.

The list of waters sold chiefly for table use includes the names of many springs and wells that have been widely published. Table waters must be agreeably light and pleasant, and few are strongly mineralized. Some, however, contain decidedly more sodium in the form of bicarbonate of soda and chloride of soda than ordinary well or spring water, and many are artificially carbonated to make them lighter and to make them keep better.

In fact table waters may be divided into two classes, the still water sold chiefly in large bottles, carboys, and even barrels, for households, offices, and factories. Though such waters sell at a low price, many for less than 10 cents per gallon, they form the bulk of the mineral-water trade as represented by the statistics given in this report. The totals include the production of a great number of springs of small annual output supplying a purely local trade, and a few springs from which hundreds of thousands and even millions of gallons of water are sold yearly. So large is the output of a few of these springs that in 1909 four springs marketed 19,000,000 gallons of table water, compared with 29,000,000 gallons marketed by all the others. Sold chiefly to dwellers in towns and cities where public supplies are suspicious or objectionable, they meet a demand for pure and pleasant drinking water.

The other group of table water includes the output of a comparatively small number of springs, but as the waters are widely advertised the total sales reach millions of gallons annually. These waters are sold in small packages—quarts, pints, and splits—and the largest part of the output is artificially carbonated. Hence the average selling price, over 50 cents per gallon, is much higher than that of the first group. These waters are mostly sold for bar, restaurant, and hotel trade, and are to be classed as luxuries rather than necessaries. By reason of their high selling price the total value of the annual sales is greater than that of the first group, although the quantity marketed is much smaller.

MINERALIZATION OF WELL AND SPRING WATERS.

The commercial wells and springs yield waters that fell on the surface in the form of rain or snow and passed into the soil. There are some highly mineralized waters—notably the salt sulphur waters—that may have been derived from brined sea water, and a few thermal springs yield supplies that may have originated in molten masses of rock far underground; but both of these sources are of such small importance, ranked by volume of output sold, compared with the water of relatively shallow source and of undoubted meteoric origin, that their peculiarities of mineralization will not be discussed here.

Ordinary well and spring supplies, table and medicinal, since they represent rain water, were orginally not mineralized. Their present peculiarities of composition represent minerals dissolved during their sojourn underground and in their journey from the point at which they entered the soil to their point of recovery at spring or well. The length of this journey, the duration of the stay underground, and the physical and chemical peculiarities of the soil and rocks traversed are all factors in the final mineralization. Shallow springs flowing from beds of sand and gravel containing little easily soluble material yield slightly mineralized water; deep wells drawing on waters that have been long buried or have traveled far through soluble materials yield highly mineralized supplies. In regions of stratified flat-lying deposits waters from the same bed or formation usually have essentially the same characteristic, or what may be called a family resemblance. In regions of igneous rocks or in regions where the rocks have been much folded or displaced there is much less similarity, and springs a few feet apart may differ greatly in quality.

Various schemes for the classification of mineral waters have been proposed, but none is altogether satisfactory. The substances a water may contain are many, the exact relations between these substances in solutions so dilute, as most natural waters are not known to the chemist, and the possible gradations of mineralization are infinite. These reasons and the additional reason that all the waters in any one class in any scheme of classification yet proposed would not necessarily have the same physiologic action, and hence the same medicinal value, cause the devising of a scheme of classification that will fit all needs to seem impossible.

A further matter that may prove of importance in this regard is the occurrence of that unstable element radium. Radium emanation has been detected in many spring waters, and the presence of the element may explain the cures wrought by some waters that were regarded as only a little mineralized. The radioactivity of a water rapidly decreases, and it is possible that this fact explains why some medicinal waters have greater efficacy when fresh than when they have been bottled for some time.

VALUATION OF SPRING WATERS.

In this report, as in past reports of mineral-water production, the valuations given are based on the returns made by spring owners and represent the price per gallon at the spring. In the returns for 1906, 1907, and 1908 the attempt was made to bring all returns to a common basis by making the unit of value the retail price, this figure being chosen in preference to the wholesale price because of its representing the money value of the waters sold. In this report the basis of valuation is the wholesale price per gallon at the spring, the change to wholesale price being made in order to have the same basis of valuation that is used for all other mineral products. As a matter of fact, however, both average wholesale price at the spring and average retail price at the spring have little significance because of the wide differences in selling price between still drinking waters marketed by the barrel or a flat rate per month and medicinal waters or carbonated table waters distributed in bottles.

Still, the figures of total value are useful, as they show the relative importance of the medicinal and the table water sales in different States and give an idea of the magnitude of the mineral-water trade as a whole.

IMPORTANCE OF MINERAL-WATER TRADE.

In the discussion of the scope of the statistics given in these reports it was pointed out that they can not represent the actual importance of the mineral-water trade if the term mineral water is used in its broadest commercial significance. At many resorts the quantity of water furnished free to guests is far greater than the quantity actually sold, and this without taking into account the water used for bathing. The manufacture of artificial carbonated waters, vichy, seltzer, etc., has become an important industry, though as they are not much advertised little thought is given them. The artificial medicinal waters and proprietary remedies are widely known; but they do not begin to equal in quantity sold or even in value the much less advertised table water. As to the sweetened beverages, certain of these are known throughout the country, and their marketing involves an annual expenditure of millions of dollars. There are no figures to show the output of these artificial table and mineral waters or the value of the quantity sold every year. Some idea of the importance of the trade in sweetened beverages may be had from the table given on another page. The totals presented in this report are sufficient to show that the mineral-water industry is vigorous and is steadily gaining in importance. That its growth will be as rapid in the next decade as in the last seems doubtful, but there can be no question of its continued progress.

TRADE IN SOFT DRINKS.

The total quantity of mineral water reported sold in 1909 by springs and wells that made returns of sales for that year amounted to 64,674,486 gallons. Besides this total, which represents water sold as water, a large quantity of water was sold in the form of sweetened beverages. There is no way of accurately estimating this quantity, but the spring owners that reported sales gave the total quantity thus used as 6,240,240 gallons. It is difficult to estimate the value of the water, since the actual cost to the spring or well owner varies greatly, but the total value of the beverages made from it amounted to millions of dollars. The figures given below, compiled from the returns received, show how important the manufacture of soft drinks is to the spring owners in certain States:

Quantity of water used in the manufacture of soft drinks in 1909, in gallons.

Wisconsin	1,225,077	New Hampshire	254,860
Michigan	773,000	Missouri	205,480
Massachusetts	642,766	Other States	2,264,349
Louisiana	445,000		
Minnesota	429,708	Total	6,240,240

REVIEW OF THE MINERAL-WATER TRADE IN 1909.

OUTPUT AND VALUE.

The statements received from spring proprietors show that the mineral-water trade of the United States was in a prosperous condition during 1909. The total sales amounted to 64,674,486 gallons, a gain of 8,805,666, or 15.76 per cent, over the total sales reported for 1908.

The largest percentages of increase among the several States are those of Louisiana (243 per cent), Georgia (102 per cent), West Virginia (79 per cent), Kansas (70 per cent), and Connecticut (63 per cent). The gains reported from most of these States and much of the gain in the output of the whole country are to be attributed to new production—that is, to returns from springs that reported for the first time or have not reported for several years. Another factor in the good showing for 1909 is the small number of delinquent springs, those that reported sales in 1908 but made no returns in 1909.

The total number of "new" springs was 146, the largest gain in number reporting any year during the last decade. The springs that reported sales in 1908 but made no returns in 1909 numbered only 27.

The large number of new springs does not necessarily show, however, that the number of springs that sold water for the first time was actually greater in 1909 than in preceding years, though such was probably the case; but it is evidence, corroborated by the small number of delinquent springs in 1909, that the effort to get returns from all producers was more successful in 1909 than ever before. It is hardly necessary to say that this success could not have been achieved without the hearty cooperation of spring owners and that to them whatever excellence this report possesses is chiefly due.

Although the gain from new production is responsible for a large and perhaps the largest share of the increase in output shown for 1909, yet the statements of spring owners go to prove that some of their increased output resulted from larger sales by springs that have reported for years. Several factors were responsible for the large sales. Chief among them was the generally prosperous condition of the country. Another, and perhaps nearly as important a factor, was the rapid growth of the demand for pure and agreeable drinking water, a demand that owes its growth to the activity of state and national bureaus in calling attention to the need of greater regard being given to the prevention of water-borne diseases. Still other factors are the enterprise shown by various spring proprietors in calling attention to the merits of their waters, and the steadily growing interest in the therapeutic value of mineral waters and the benefits to be derived from a properly supervised course of treatment at a spring resort.

The following table shows the number of springs listed and the quantity and value of their output from 1883, the year the Survey began to collect statistics of production, to 1909, inclusive:

Estimated production of mineral waters, 1883–1909.

Year.	Number of springs.	Quantity sold (gallons).	Value.	Year.	Number of springs.	Quantity sold (gallons).	Value.
1883	189	7,529,423	$1,119,603	1897	441	23,255,911	$4,599,106
1884	189	10,215,328	1,459,143	1898	484	28,853,464	8,051,833
1885	224	9,148,401	1,312,845	1899	541	39,562,136	6,948,030
1886	225	8,950,317	1,284,070	1900	561	45,276,995	5,791,805
1887	215	8,259,609	1,261,463	1901	659	54,733,661	7,443,904
1888	198	9,578,648	1,679,302	1902	721	63,174,552	8,634,179
1889	258	12,780,471	1,748,458	1903	*a* 560	40,107,147	6,788,426
1890	273	13,907,418	2,600,750	1904	*a* 484	41,969,145	6,218,873
1891	288	18,392,732	2,996,259	1905	*a* 564	46,544,361	6,491,251
1892	283	21,876,604	4,905,970	1906	*a* 582	48,108,580	8,028,387
1893	330	23,544,495	4,246,734	1907	*a* 584	52,060,520	7,331,503
1894	357	21,569,608	3,741,846	1908	*a* 695	55,868,820	6,712,680
1895	370	21,463,543	4,254,337	1909	*a* 760	64,674,486	6,894,134
1896	377	25,795,312	4,136,192				

a Springs reporting sales.

Details of the trade in 1908 and 1909 are presented in the following table for ease of comparison:

Production and value of mineral waters in the United States, 1908 and 1909, by States.

1908.

State or Territory.	Number of springs reporting sales.	Quantity sold (gallons).	Average retail price per gallon at spring.	Value of medicinal waters.	Value of table waters.	Total value of mineral waters.
Alabama	8	99,192	$0.32	$24,289	$7,294	$31,583
Arkansas	10	1,175,053	.18	181,392	31,443	212,835
California	40	1,960,770	.20	128,612	265,308	393,920
Colorado	11	761,150	.17	46,625	81,095	127,720
Connecticut	15	424,826	.09	2,758	33,646	36,404
Florida	12	123,552	.17	16,469	4,100	20,569
Georgia	14	346,198	.15	14,710	36,220	50,930
Illinois	17	685,763	.09	23,930	34,974	58,904
Indiana	15	615,429	.69	411,915	14,148	426,063
Iowa	6	253,500	.12	21,650	9,700	31,350
Kansas	16	370,943	.20	57,279	17,101	74,380
Kentucky	12	797,186	.08	31,407	34,705	66,112
Louisiana	3	400,500	.13	16,500	35,520	52,020
Maine	27	1,182,322	.33	14,461	379,885	394,346
Maryland	8	806,673	.09	2,100	73,758	75,858
Massachusetts	61	4,395,049	.05	42,511	185,396	227,907
Michigan	24	2,004,433	.04	5,995	82,915	88,910
Minnesota	11	10,985,536	.05	4,561	547,425	551,986
Mississippi	8	257,200	.21	39,730	13,050	52,780
Missouri	30	682,821	.13	57,062	28,981	86,043
Nebraska	3	48,498	.23	3,779	7,268	11,047
New Hampshire	9	835,349	.28	103,008	132,512	235,520
New Jersey	13	1,199,023	.11	10,525	116,078	126,603
New Mexico	6	152,200	.11	9,100	6,960	16,060
New York	47	8,007,092	.11	126,629	728,519	855,148
North Carolina	18	160,195	.17	24,282	2,881	27,163
Ohio	27	2,409,598	.05	26,799	98,139	124,938
Oklahoma	9	534,114	.10	42,237	10,542	52,779
Oregon	6	25,350	.35	5,670	3,160	8,830
Pennsylvania	32	1,430,489	.13	52,722	128,167	180,889
Rhode Island	9	594,208	.07	1,325	38,080	39,405
South Carolina	13	271,572	.26	47,402	23,535	70,937
Tennessee	14	712,912	.08	45,445	15,448	60,893
Texas	36	1,586,634	.10	138,863	12,169	151,032
Vermont	5	107,800	.15	6,718	9,662	16,380
Virginia	46	2,009,614	.10	97,502	109,613	207,115
Washington	5	38,900	.35	3,375	10,275	13,650
West Virginia	9	130,295	.50	40,769	23,771	64,540
Wisconsin	28	6,084,571	.20	387,522	852,385	1,239,907
Other States[a]	12	1,202,310	.12	19,984	129,240	149,224
Total	695	55,868,820	.12	2,337,612	4,375,068	6,712,680

1909.

State or Territory.	Number of springs reporting sales.	Quantity sold (gallons).	Average retail price per gallon at spring.	Value of medicinal waters.	Value of table waters.	Total value of mineral waters.
Alabama	10	116,645	$0.25	$21,208	$7,387	$28,595
Arkansas	10	1,213,742	.13	92,806	60,357	153,163
California	44	2,179,187	.20	137,738	306,492	444,230
Colorado	15	1,077,820	.10	25,570	85,588	111,158
Connecticut	22	691,296	.06	610	41,765	42,375
Florida	12	113,944	.15	5,767	10,767	16,534
Georgia	13	782,166	.13	18,582	81,306	99,888
Illinois	14	639,460	.08	4,821	44,287	49,108
Indiana	18	663,815	.67	432,554	13,695	446,249
Iowa	6	184,000	.06	3,200	10,916	14,116
Kansas	19	633,024	.14	67,040	22,756	89,796
Kentucky	16	756,425	.10	39,092	34,675	73,767
Louisiana	5	1,375,000	.08	5,000	98,850	103,850
Maine	33	1,515,541	.27	18,139	384,454	402,593
Maryland	7	938,496	.10	2,164	89,405	91,569
Massachusetts	60	5,424,082	.04	34,009	194,058	228,067
Michigan	19	2,760,604	.04	6,099	98,355	104,454
Minnesota	20	13,746,142	.04	3,798	610,493	614,291
Mississippi	9	307,315	.17	41,575	11,350	52,925
Missouri	28	765,032	.15	72,490	38,958	111,448
New Hampshire	10	934,072	.26	217,273	28,334	245,607

[a] Includes Alaska, Arizona, Delaware, District of Columbia, Idaho, Montana, North Dakota, South Dakota, Utah, and Wyoming.

Production and value of mineral waters in the United States, 1908 and 1909, by States—Continued.

1909—Continued.

State or Territory.	Number of springs reporting sales.	Quantity sold (gallons).	Average retail price per gallon at spring.	Value of medicinal waters.	Value of table waters.	Total value of mineral waters.
New Jersey	11	1,419,500	.09	2,000	125,025	127,025
New Mexico	6	157,700	.18	13,923	14,916	28,839
New York	52	8,813,563	.11	186,162	762,163	948,325
North Carolina	15	128,171	.16	18,208	2,350	20,558
Ohio	31	2,709,060	.04	22,409	90,366	112,775
Oklahoma	12	563,475	.06	12,519	22,675	35,194
Oregon	4	41,100	.26	4,350	6,370	10,720
Pennsylvania	42	2,177,967	.11	67,410	173,446	240,856
Rhode Island	9	502,970	.07	0	35,438	35,438
South Carolina	15	372,880	.26	52,925	42,960	95,885
South Dakota	3	17,220	.13	100	2,061	2,161
Tennessee	18	934,912	.08	65,267	10,918	76,185
Texas	34	1,033,476	.10	58,633	39,866	98,499
Vermont	3	66,100	.20	3,993	9,333	13,326
Virginia	49	1,504,530	.14	102,296	101,159	203,455
Washington	7	39,260	.41	4,433	11,525	15,958
West Virginia	13	233,349	.28	35,014	29,716	64,730
Wisconsin	34	6,101,882	.19	125,898	1,006,341	1,132,239
Other States[a]	12	1,039,563	.10	1,342	106,841	108,183
Total	760	64,674,486	.11	2,026,417	4,867,717	6,894,134

[a] Includes Delaware, District of Columbia, Idaho, Montana, Nebraska, North Dakota, Utah, and Wyoming.

Inspection of the foregoing table reveals the fact that the rank of the States in mineral-water production differs according to whether the total number of springs reporting sales, the quantity of the water sold, or the value of the sales (medicinal or table waters) is selected as the basis of comparison. The 10 leading States compare as follows:

Rank of 10 leading States based on springs reporting, on quantity sold, and on value of output, 1909.

	Number of springs reporting.	Quantity sold.	Value of medicinal waters.	Value of table waters.	Total value.
1	Massachusetts	Minnesota	Indiana	Wisconsin	Wisconsin.
2	New York	New York	New Hampshire	New York	New York.
3	Virginia	Wisconsin	New York	Minnesota	Minnesota.
4	California	Massachusetts	California	Maine	Indiana.
5	Pennsylvania	Michigan	Wisconsin	California	California.
6	Texas; Wisconsin	Ohio	Virginia	Massachusetts	Maine.
7	Maine	California	Arkansas	Pennsylvania	New Hampshire.
8	Ohio	Pennsylvania	Missouri	New Jersey	Pennsylvania.
9	Missouri	Maine	Pennsylvania	Virginia	Virginia.
10	Connecticut	Virginia	Kansas	Louisiana	Massachusetts.

In these groups certain States rank much higher than the States next in importance. For instance, in quantity of water sold, Minnesota, with reported sales of 13,746,142 gallons, is almost 5,000,000 gallons ahead of the second State, New York, and the first four States—Minnesota, New York, Wisconsin, and Massachusetts—produced over 24,000,000 gallons, or 40 per cent of the output of the entire country.

In the same way if the value of the medicinal waters be taken as a basis, Indiana, with total sales valued at over $400,000, outranks the next State, New Hampshire, by a large margin. Again, if the value of the table water sold be used in comparing the relative importance of the States, Wisconsin, with sales reported at $1,006,341, and New York, with sales amounting to more than $760,000, easily lead, as the sales from the third State, Minnesota, amounted to $610,000.

In total value of both medicinal and table waters, Wisconsin was easily first, the total value of the output amounting to $1,132,239. The second State, New York, with total sales valued at over $948,000, leads the next State, Minnesota, by over $330,000.

The commanding lead of Wisconsin in total value of output is due to sales of both medicinal and table waters. The rank of Indiana is due almost wholly to medicinal water, that of New York to table and mineral water, and that of Minnesota almost wholly to table water.

This table brings out the interesting fact that although some States, like Massachusetts, owe their rank as producers to the combining of many relatively small outputs, others, such as Minnesota, lead by reason of the large quantity sold from a few wells or springs.

CONDITION OF THE TRADE.

As has been stated, the large gain in production shown by the returns for 1909 is in part the result of the increased number of springs reporting sales and in part the result of larger sales by springs that have reported for years.

The 15 more important States named in the accompanying list, that is those from which sales amounting to over 1,000,000 gallons were reported, are, in order of rank, Minnesota, New York, Wisconsin, Massachusetts, Michigan, Ohio, California, Pennsylvania, Maine, Virginia, New Jersey, Louisiana, Arkansas, Colorado, and Texas.

Trade conditions in these States show some differences; thus, the returns from Minnesota, New York, Wisconsin, Massachusetts, Michigan, Ohio, California, Pennsylvania, Maine, Louisiana, Arkansas, New Jersey, and Colorado show larger quantities of water sold than in 1908; only Virginia and Texas reported a decline in sales for 1909. The distribution of the 13 leading States that reported gains shows that the progress of the mineral-water trade during 1909 was not confined to any one section of the country, but was general.

The producing springs in these 15 States reported their total output of water as 53,052,096 gallons, or 82 per cent of the total output of the country, and the total gain in new springs in these States was 43. These figures indicate that the gain in production came largely from new springs. Comparison of the returns for 1908 and 1909 shows that the total value of the water sold in 1909 was but little larger than the value of the 1908 output because of the lower valuation put on medicinal waters.

Number of springs and quantity and value of mineral waters sold in 1908 and 1909.

State or Territory.	1908.			1909.		
	Springs reporting.	Quantity sold (gallons).	Value.	Springs reporting.	Quantity sold (gallons).	Value.
Alabama	8	99,192	$31,583	10	116,645	$28,595
Alaska	1	....	....	0	....	....
Arizona	1	....	....	0	....	....
Arkansas	10	1,175,053	212,835	10	1,213,742	153,163
California	40	1,960,770	393,920	44	2,179,187	444,230
Colorado	11	761,150	127,720	15	1,077,820	111,158
Connecticut	15	424,826	36,404	22	691,296	42,375
Delaware	1	....	....	1	....	....
District of Columbia	1	....	....	2	....	....
Florida	12	123,552	20,569	12	113,944	16,534
Georgia	14	346,198	50,936	13	782,166	99,888
Idaho	1	....	....	2	....	....
Illinois	17	685,763	58,904	14	639,460	49,108
Indiana	15	615,429	426,063	18	663,815	446,249
Iowa	6	253,500	31,350	6	184,000	14,116
Kansas	16	370,943	74,380	19	633,024	89,796
Kentucky	12	797,186	66,112	16	756,425	73,767
Louisiana	3	400,500	52,020	5	1,375,000	103,850
Maine	27	1,182,322	394,346	33	1,515,541	402,593
Maryland	8	806,673	75,858	7	938,496	91,569
Massachusetts	61	4,395,049	227,907	60	5,424,082	228,067
Michigan	24	2,004,433	88,910	19	2,760,604	104,454
Minnesota	11	10,985,536	551,986	20	13,746,142	614,291
Mississippi	8	257,200	52,780	9	307,315	52,925
Missouri	30	682,821	86,043	28	765,032	111,448
Montana	1	....	....	2	....	....
Nebraska	3	48,498	11,047	1	....	....
New Hampshire	9	835,349	235,520	10	934,072	245,607
New Jersey	13	1,199,023	126,603	11	1,419,500	127,025
New Mexico	6	152,200	16,060	6	157,700	28,839
New York	47	8,007,092	855,148	52	8,813,563	948,325
North Carolina	18	160,195	27,163	15	128,171	20,558
North Dakota	1	....	....	1	....	....
Ohio	27	2,409,598	124,938	31	2,709,060	112,775
Oklahoma	9	534,114	52,779	12	563,475	35,194
Oregon	6	25,350	8,830	4	41,100	10,720
Pennsylvania	32	1,430,489	180,889	42	2,177,967	240,856
Rhode Island	9	594,208	39,405	9	502,970	35,438
South Carolina	13	271,572	70,937	15	372,880	95,885
South Dakota	3	....	....	3	17,220	2,161
Tennessee	14	712,912	60,893	18	934,912	76,185
Texas	36	1,586,634	151,032	34	1,033,476	98,499
Utah	1	....	....	1	....	....
Vermont	5	107,800	16,380	3	66,100	13,326
Virginia	46	2,009,614	207,115	49	1,504,530	203,455
Washington	5	38,900	13,650	7	39,260	15,958
West Virginia	9	130,295	64,540	13	233,349	64,730
Wisconsin	28	6,084,571	1,239,907	34	6,101,882	1,132,239
Wyoming	1	....	....	2	....	....
States or Territories of one or two springs each, including those for which figures are not given in the above list	....	1,202,310	149,224	....	1,039,563	108,183
Total	695	55,868,820	6,712,680	760	64,674,486	6,894,134

Comparative production of mineral waters, 1908–9.

State or Territory.	Increase (+) or decrease (−) in number of springs reporting.	Increase (+) or decrease (−) in gallons sold.	Percentage of increase (+) or decrease (−) in gallons sold.	Increase (+) or decrease (−) in value of product.	Percentage of increase (+) or decrease (−) in value of product.
labama	+ 2	+ 17,453	+ 17.60	− $2,988	− 9.46
rkansas	....	+ 38,689	+ 3.29	− 59,672	−28.04
alifornia	+ 4	+ 218,417	+ 11.14	+ 50,310	+12.77
olorado	+ 4	+ 316,670	+ 41.60	− 16,562	−12.97
onnecticut	+ 7	+ 266,470	+ 62.72	+ 5,971	+16.40
lorida	....	− 9,608	− 7.78	− 4,035	−19.62
eorgia	− 1	+ 435,968	+102.59	+ 48,958	+96.15
linois	− 3	− 46,303	− 6.75	− 9,796	−16.63
ıdiana	+ 3	+ 48,386	+ 7.86	+ 20,186	+ 4.74
owa	....	− 69,500	− 27.42	− 17,234	−54.97
ansas	+ 3	+ 262,081	+ 70.65	+ 15,416	+20.73
entucky	+ 4	− 40,761	− 5.11	+ 7,655	+11.58
ouisiana	+ 2	+ 974,500	+243.32	+ 51,830	+99.63
aine	+ 6	+ 333,219	+ 28.18	+ 8,247	+ 2.09
aryland	− 1	+ 131,823	+ 16.34	+ 15,711	+20.71
assachusetts	− 1	+1,029,033	+ 23.41	+ 160	+ 0.07
ichigan	− 5	+ 756,171	+ 37.72	+ 15,544	+17.48
innesota	+ 9	+2,760,606	+ 25.13	+ 62,305	+11.29
ississippi	+ 1	+ 50,115	+ 19.48	+ 145	+ 0.27
issouri	− 2	+ 82,211	+ 12.04	+ 25,405	+29.53
ew Hampshire	+ 1	+ 98,723	+ 11.82	+ 10,087	+ 4.28
ew Jersey	− 2	+ 220,477	+ 18.39	+ 422	+ 0.33
ew Mexico	....	+ 5,500	+ 3.61	+ 12,779	+79.57
ew York	+ 5	+ 806,471	+ 10.07	+ 93,177	+10.90
orth Carolina	− 3	− 32,024	− 19.99	− 6,605	−24.32
hio	+ 4	+ 299,462	+ 12.43	− 12,163	− 9.74
klahoma	+ 3	+ 29,361	+ 5.50	− 17,585	−33.32
regon	− 2	+ 15,750	+ 62.13	+ 1,890	+21.40
nnsylvania	+10	+ 747,478	+ 52.25	+ 59,967	+33.15
hode Island	....	− 91,238	− 15.36	− 3,967	−10.07
uth Carolina	+ 2	+ 101,308	+ 37.30	+ 24,948	+35.17
nnessee	+ 4	+ 222,000	+ 3 .14	+ 15,292	+25.11
xas	− 2	− 553,158	− 34.86	− 52,533	−34.78
rmont	− 2	− 41,700	− 38.68	− 3,054	−18.64
rginia	+ 3	− 505,084	− 25.13	− 3,660	− 1.77
ashington	+ 2	+ 360	+ 0.93	+ 2,308	+16.91
est Virginia	+ 4	+ 103,054	+ 79.07	+ 190	+ 0.29
isconsin	+ 6	+ 17,311	+ 0.28	−107,668	− 8.68
her States and Territories not included above	....	− 194,025	− 15.73	− 49,927	−31.15
Net increase, 1909	+65	+8,805,666	+ 15.76	+181,454	+ 2.70

TRADE PROSPECTS.

As has been pointed out in previous reports, the continued pros-perity of the mineral-water trade shows that the demand for pure cinking water has come to stay. New springs may seek trade, cd ones may go out of business, but the total number of springs lds fair to increase indefinitely, as will the total quantity of water sld. Aside from the demand for pure water there are other factors vhich assure the continued prosperity of the mineral-water trade. These are the increase in the per capita wealth of the country, the tndency to indulge in luxuries that accompanies increasing wealth, te movement of the population toward cities and towns, and the seady growth in the use of mineral waters in the treatment of disease. I is obvious that the variety of mineral waters that can be put on te market and the fact that a large proportion of the springs report-ig sales supply a purely local demand tend to prevent the formation o a mineral-water trust. Although it would be possible for the poprietors of the springs at a few noted resorts or the owners of a number of springs that are widely advertised to combine, yet the opportunities for competition are so good and the sentiment against any monopolization of natural resources is so strong in many States that there is little likelihood of any attempt being made to combine all the important medicinal springs, and small chance that such a combination would prove financially successful. An attempt to combine all table-water springs, the great majority of which depend on local markets and are open to competition at any time, seems altogether unlikely.

At the same time, the successful conduct of any business calls for energy and common sense, and those spring proprietors who show these qualities in the highest degree will obtain the largest share, whether they limit their sales to local markets or ship water to all parts of the United States. And since the exploitation of a mineral spring on a large scale calls for a heavy investment of capital and since the larger the amount of water sold from a spring, the smaller, within limits, need be the total profit per gallon, it follows that the advantage in competition, the business ability displayed being the same, lies with the concern that can spend large sums in pushing sales. Hence there is every reason to believe that mineral-water corporations larger than any now doing business will be organized.

IMPORTS AND EXPORTS.

IMPORTS.

In 1909 the total imports, which included natural, semiartificial, and strictly artificial waters, amounted to 3,464,524 gallons, valued at $1,085,177. These figures are reported by the Bureau of Statistics of the Department of Commerce and Labor and represent imports entered for consumption, not total imports. The valuation is that assessed by customs officials. An important factor to be considered in comparing statistics is the effect within the last five years of the pure-food laws, which require artificial or semiartificial waters to be properly labeled when offered for sale.

The following table shows the quantity and value of the waters entered for consumption in the United States for the last ten years:

Mineral waters imported and entered for consumption in the United States, 1900–1909, in gallons.

Year.	Mineral waters.		Year.	Mineral waters.	
	Quantity.	Value.		Quantity.	Value.
1900	2,382,410	$663,803	1905	3,150,030	$926,357
1901	2,567,323	744,392	1906	3,157,609	1,012,333
1902	2,460,119	712,714	1907	3,497,239	1,165,555
1903	2,851,964	846,294	1908	2,912,398	1,033,047
1904	2,901,828	868,262	1909	3,464,524	1,085,177

EXPORTS.

Considerable quantities of certain domestic waters are said to be shipped to Canada and other foreign countries, but no account of such shipments is taken by the Bureau of Statistics, and no exports have been reported by the Government since 1883.

TRADE BY STATES.

ALABAMA.

The mineral-water trade of Alabama, according to the returns from producers, prospered in 1909; the total sales were 116,645 gallons, compared with 99,192 gallons in 1908, a gain of 17,453 gallons, or 17.6 per cent. The value of the water sold, however, declined from $31,583 in 1908 to $28,595, a loss of $2,988, or 9.46 per cent. The average selling price per gallon was 25 cents, or 7 cents less than in 1908. Two new springs reported sales in 1909, the Bromberg Gulf Coast Lithia and the Blount Springs, making the total number to report 10. About three-fourths of the total output is used for medicinal purposes. There are resorts at 6 of the springs listed, with accomodations for more than 1,000 people, and the water at 5 is said to be used for bathing. Exclusive of the water reported sold, 20,000 gallons were used in the manufacture of soft drinks.

The 10 reporting springs are as follows:

Bailey Springs, Florence, Lauderdale County.
Blount Springs, Blount Springs, Blount County.
Bromberg Gulf Coast Lithia Spring, Bayou La Batre, Mobile County.
Healing Springs, Healing Springs, Washington County.
Ingram Lithia Wells, near Ohatchee, Calhoun County.
Livingston Mineral Springs, Livingston, Sumter County.
Luverne Mineral Spring, Luverne, Crenshaw County.
MacGregor Spring, Spring Hill, Mobile County.
Matchless Mineral Wells, east of Greenville, Butler County.
York Well, York, Sumter County.

ARKANSAS.

The reported sales of mineral waters in 1909 amounted to 1,213,742 gallons, against 1,175,053 gallons reported in 1908, a gain of 38,689 gallons, or 3.29 per cent. There was a decided fall in the reported value, however, from $212,835 in 1908 to $153,163 in 1909, a loss of $59,672, or 28.04 per cent. The estimated selling price per gallon in 1908 was 18 cents; in 1909 it was 13 cents. Two new springs were added to the list of producers in the State, the Lithia and Black Sulphur Springs and the Siloam, but the total number reporting was the same as in 1908. More than one-half of the output is used for medicinal purposes. There are resorts at or near 7 of the springs listed, with accommodations for a large number of patrons. The water at but 3 is used for bathing purposes. Besides the quantity reported as sold, there were 27,400 gallons used in the manufacture of soft drinks.

The table below shows the record for the last six years:

Production and value of mineral waters in Arkansas, 1904–1909.

Year.	Springs reporting sales.	Quantity sold (gallons).	Value.	Year.	Springs reporting sales.	Quantity sold (gallons).	Value.
1904	5	534,440	$57,107	1907	7	431,511	$85,236
1905	7	474,005	50,501	1908	10	1,175,053	212,835
1906	8	727,765	105,286	1909	10	1,213,742	153,163

The 10 reporting springs are as follows:

Arkansas Lithia Springs, near Hope, Hempstead County.
Arsenic Springs, Hot Springs, Garland County.
Howard's Mineral Wells, Sharp, Independence County.
Lithia and Black Sulphur Springs, Sulphur Springs, Benton County.
Mountain Blood Spring, near Hot Springs, Garland County.
Mountain Valley Spring, near Hot Springs, Garland County.
Ozark Lithia Spring, near Hot Springs, Garland County.
Ozarka Spring, Eureka Springs, Carroll County.
Potash Sulphur Springs, Lawrence, Garland County.
Siloam Spring, Siloam Springs, Benton County.

CALIFORNIA.

The returns from California show that owing to new springs the mineral-water output of that State increased decidedly during 1909. The sales rose from 1,960,770 gallons in 1908 to 2,179,187 gallons in 1909, a gain of 218,417 gallons, or 11.14 per cent, the average selling price for the two years being the same. Ten springs not listed in 1908 reported sales in 1909—Arrowhead, Boyes Hot Springs, Elliotta White Sulphur, Paso Robles, Radium Sulphur Springs, San Caytano, Soboba Lithia, Spiers, Tamalpais, and Vito Nuevo. The total number reporting was 44.

The following table shows the statistics for the last six years:

Production and value of mineral waters in California, 1904–1909.

Year.	Springs reporting sales.	Quantity sold (gallons).	Value.	Year.	Springs reporting sales.	Quantity sold (gallons).	Value.
1904	35	3,756,779	$899,763	1907	28	1,680,169	$460,972
1905	39	1,934,784	675,214	1908	40	1,960,770	393,920
1906	28	1,487,975	520,515	1909	44	2,179,187	444,230

Nearly three-fourths of California's mineral water is reported sold for table purposes. There are 18 resorts at these springs, with accommodations for nearly 4,000 people, and the water at 15 is used for bathing purposes also. Spring owners reported a total of 103,114 gallons used for the manufacture of soft drinks.

The 44 springs listed are as follows:

Adams Springs, Middletown, Lake County.
Ætna Spring, Lidell, Napa County.
Alhambra Spring, near Martinez, Contra Costa County.
Allen Springs, Lake County.
Arrowhead Spring, Arrowhead Springs, San Bernardino County.
Bartlett Spring, Bartlett Springs, Lake County.
Bythnia Spring, Santa Barbara, Santa Barbara County.
California Geysers, Sonoma County.
Castalian Spring, Inyo County.
Castle Rock Spring, Eubanks, Shasta County.
Console Mineral Spring, Colton, San Bernardino County.
Cooks Springs, near Williams, Colusa County.
El Granito Mineral Spring, El Cajon, San Diego County.
Elliotta White Sulphur Spring, Riverside, Riverside County.
Fouts Springs, Fouts Springs, Colusa County.
Iron Lithia and White Sulphur Springs, Eden Hot Springs, Riverside County.
Isham Springs, near San Diego, San Diego County.

Lepori Vichy Springs, near Napa City, Napa County.
Lytton Spring, Lytton, Sonoma County.
Mount Ida Mineral Spring, Wyandotte, Butte County.
Napa Soda Springs, Napa Valley, Napa County.
Nuvida Springs, Sunnyside, San Diego County.
Paso Robles Hot Springs, Paso Robles, San Luis Obispo County.
Purity Springs, Sausalito, Marin County.
Radium Sulphur Springs, Colegrove, Los Angeles County.
Samuel Soda Spring, Monticello, Napa County.
San Benito Spring, near Hollister, San Benito County.
San Caytano Spring, Santa Paula, Ventura County.
Sausalito Spring, Sausalito, Marin County.
Shasta Springs, Shasta Springs, Siskiyou County.
Soboba Lithia Hot Spring, San Jacinto, Riverside County.
Spiers Spring, near Middletown, Lake County.
Tahoe Mineral Spring, near Truckee, Nevada County.
Tamalpais Spring, San Rafael, Marin County.
Tassajara Hot Springs, near Jamesburg, Monterey County.
Tia Juana Springs, near Nestor, San Diego County.
Tolenas Spring, near Suisun City, Solano County.
Upper Soda Spring, near Dunsmuir, Siskiyou County.
Valley Springs, Valley Springs, Calaveras County.
Veronica Medicinal Springs, near Santa Barbara, Santa Barbara County.
Vito Nuevo Spring, Mono County.
Witter Medical Springs, Witter, Lake County.
Yosemite Mineral Spring, Mono Lake, Mono County.

COLORADO.

Reports from Colorado show that in 1909 the sales of mineral water exceeded the 1,000,000-gallon mark for the first time. Part of the increase came from springs that had not reported before. The total sales were 1,077,820, a gain of 316,670 gallons, or 41.60 per cent, over the output in 1908 of 761,150 gallons. The value, however, was more than 12 per cent less than for 1908, owing to the lower average price per gallon reported, 10 cents, as compared with 17 cents in 1908. Following is the record for the last six years:

Production and value of mineral waters in Colorado, 1904–1909.

Year.	Springs reporting sales.	Quantity sold (gallons).	Value.
1904	12	780,078	$120,705
1905	14	903,600	130,623
1906	12	829,850	116,366
1907	12	775,100	154,415
1908	11	761,150	127,720
1909	15	1,077,820	111,158

Four new springs were added to the list of producers in 1909, as follows: Carlsbad, Deep Rock Artesian Well, Dr. Horn Mineral, and the Pueblo Mineral, making the total number reporting 15. About two-thirds of the total output is used for the table. Of the springs reporting sales, only 3 are resorts. There are accommodations for more than 5,000 people at these springs, and the water is used for bathing. Besides the quantity reported sold 75,500, gallons were used for soft drinks.

Following is the list of reporting springs:

Boulder Springs, Crisman, Boulder County.
Canon City Soda Spring, Canon City, Fremont County.
Carlsbad Spring, near Denver, Denver County.
Clark Magnetic Mineral Spring, Pueblo, Pueblo County.
Columbia Well, Denver, Denver County.
Deer Rock Artesian Well, Denver, Denver County.
Crystal Springs, Fowler, Otero County.
Kearney Golden Spring, near Golden, Jefferson County.
Dr. Horn Mineral Springs, Colorado Springs, El Paso County.
Marshall Magnetic Mineral Spring, Pueblo, Pueblo County.
Navaho, Shoshone, Manitou, and Cheyenne Springs, Manitou, El Paso County.
Pueblo Mineral Springs, Pueblo, Pueblo County.
Ute Chief Spring, Manitou, El Paso County.
Ute Iron, Ouray, and Little Chief Springs, Manitou, El Paso County.
Yampah Spring, Glenwood Springs, Garfield County.

CONNECTICUT.

Returns from Connecticut indicate a decided gain in mineral-water output during 1909; the reported sales were 691,296 gallons, 62.72 per cent more than for 1908. Much of this gain is to be credited to springs reporting for the first time. The value increased from $36,404 in 1908 to $42,375 in 1909, a gain of 16.40 per cent. Seven new springs reported, bringing the total number reporting up to 22. The new springs are as follows: Ansantawae, Buttress, Chalybeate, Diamond Mineral, Highland Mineral, Nonquit, and Quinnipiac. Practically the entire mineral-water output of the State is sold for table purposes. There are no resorts at any of these springs, nor is the water used for bathing. In addition to the quantity reported sold, 112,387 gallons are stated to have been used in the manufacture of soft drinks.

The list of commercial springs is as follows:

Ansantawae Spring, Milford, New Haven County.
Arethusa Spring, Seymour, New Haven County.
Buttress Spring, Woodbridge, New Haven County.
Chalybeate Spring, Oxford, New Haven County.
Cherry Hill Spring, Hamden, New Haven County.
Crystal Spring, near Little River, Middlesex County.
Diamond Mineral Springs, Cheshire, New Haven County.
Elco Springs, Bristol, Hartford County.
Granite Rock Spring, Higganum, Middlesex County.
Highland Mineral Spring, Easton, Fairfield County.
Highland Spring, near Mount Higbee, Middlesex County.
Hillside Spring, West Meriden, New Haven County.
Live Oak Spring, Meriden, New Haven County.
Mohican Springs, Fairfield, Fairfield County.
Nonquit Spring, Fairfield, Fairfield County.
Pequabuck Mountain Spring, Bristol, Hartford County.
Quinnipiac Spring, Bridgeport, Fairfield County.
Red Rock Spring, Meriden, New Haven County.
Rock Ledge Spring, Monotowese, New Haven County.
Stafford Mineral Springs, Stafford Springs, Tolland County.
Varuna Spring, Stamford, Fairfield County.
Venture Rock Spring, Stonington, New London County.

DELAWARE.

In 1909, as in 1908, but one spring reported sales. Its output increased. The water is used entirely for table purposes, and is sold chiefly in Wilmington. The spring is:

Kiamensi Spring, near Wilmington, Newcastle County.

DISTRICT OF COLUMBIA.

Sales from a new spring substantially increased the output of mineral waters in 1909. The water from the two springs is used entirely for table purposes and is sold in Washington. The names of the springs are:

Gitche Crystal Spring, Benning.
Red Oak Spring, near Langdon.

FLORIDA.

Returns from Florida show that the mineral-water output declined both in quantity and in value during 1909; no new springs reported and most of the old springs sold less water than in 1908. The total sales were 113,944 gallons, and the value was $16,534, a decline of 7.78 per cent in quantity and of 19.62 per cent in value. The average price per gallon was 15 cents, 2 cents less than the average reported for 1908. There were 12 reporting springs, as in 1908. Nearly two-thirds of the total output is used for the table. Resorts are situated at 7 of these springs, with accommodations for over 1,000 people, and the water at 6 is used for bathing. About 15,000 gallons were reported used in the manufacture of soft drinks.

The springs listed are as follows:

Benson Spring, Enterprise, Volusia County.
Cedar Spring, near Jacksonville, Duval County.
Dishong Spring, Tampa, Hillsboro County.
Espiritu Santo Spring, Tampa Bay, Hillsboro County.
Lackawanna Spring, near Jacksonville, Duval County.
Magnolia Spring, Magnolia Springs, Clay County.
Orange City Mineral Spring, Orange City, Volusia County.
Panacea Mineral Springs, Panacea, Wakulla County.
Quisisana Spring, Green Cove Springs, Clay County.
Suwanee Sulphur Springs, Suwanee, Suwanee County.
Wekiwa Springs, Wekiwa Springs, Orange County.
Welaka Mineral Spring, Welaka, Putnam County.

GEORGIA.

A great advance in the sales of mineral water in Georgia during 1909 is shown by the returns, the output advancing from 346,198 gallons, valued at $50,930 in 1908, to 782,166 gallons, valued at $99,888 in 1909, a gain of 435,968 gallons, or 102.59 per cent in quantity, and of $48,958, or 96.15 per cent in value. Two springs made returns for the first time, the Bowden Lithia and the Chalybeate, the total number listed being 13. Table waters constitute the bulk of the sales reported. Resorts are situated at 5 of the springs, accommodating about 1,000 people, and the water at 4 is said to be used for bathing.

Following is a list of reporting springs:

Benscot Lithia Springs, Austell, Cobb County.
Bowden Lithia Spring, Lithia Springs, Douglas County.
Catoosa Springs, Catoosa Springs, Catoosa County.
Chalybeate Spring, Chalybeate, Meriwether County.
Daniel Mineral Spring, Union Point, Greene County.
Electric Spring, Hillman, Taliaferro County.
High Rock Spring, near Atlanta, Fulton County.
Menlo Springs, Menlo, Chattooga County.
Miller's Spring, Milledgeville, Baldwin County.
Miona Spring, near Oglethorpe, Macon County.
Utoy Rock Spring, Utoy, Fulton County.
White Elk Spring, near Macon, Bibb County.
White Oak Mineral Spring, Macon, Bibb County.

IDAHO.

Although one new spring in Idaho, the Blue Lakes Spring, reported sales in 1909, the quantity of water sold was less than in 1908. One of the two springs is a resort, but at neither is the water used for bathing. At one a considerable quantity was used in the manufacture of soft drinks.

The names of the springs follow:

Blue Lake Springs, Twin Falls, Twin Falls County.
Idanha Spring, Soda Springs, Bannock County.

ILLINOIS.

The sales of mineral water in Illinois during 1909 fell off in both quantity and value. According to the returns received, there were sold during the year 639,460 gallons of water, valued at $49,108, an average price of 8 cents. These totals, compared with those furnished for 1908 of 685,763 gallons, valued at $58,904, show a decrease of 46,303 gallons, or 6.75 per cent, in quantity and of $9,796, or 16.63 per cent, in value. One new spring reported, the Montgomery Magnesia, making the total number of commercial springs 14. Practically the entire output of the State was used for table purposes. Only 2 of the springs are resorts and at only 3 is the water used for bathing. A considerable quantity of water was reported used in the manufacture of soft drinks. The springs listed are:

Abana Mineral Springs, Libertyville, Lake County.
Aqua Vitae Mineral Spring, Maquon, Knox County.
Central Park Sulphur, Peoria, Peoria County.
Diamond Mineral Springs, near Grantfork, Madison County.
Gravel Springs, near Jacksonville, Morgan County.
Greenup Mineral Spring, Greenup, Cumberland County.
Montgomery Magnesia Spring, Montgomery, Kane County.
New Life Mineral Spring, near Ripley, Brown County.
Original Mineral Springs, Okawville, Washington County.
Pekin Mineral Spring, Pekin, Tazewell County.
Peoria Mineral Springs, Peoria, Peoria County.
Sanicula Spring, Ottawa, Lasalle County.
White Diamond Spring, South Elgin, Kane County.
White Eagle Spring, Edgemont, St. Clair County.

INDIANA.

The record of the mineral-water trade in Indiana during 1909 shows a small gain in both quantity and value. The sales amounted to 663,815 gallons, valued at $446,249, as compared with 615,429 gallons, valued at $426,063 in 1908, a gain of 48,386 gallons, or 7.86 per cent, in quantity and of $20,186, or 4.74 per cent, in value. A notable feature of the trade in this State is the comparatively high price per gallon, 69 cents in 1908 and 67 cents in 1909. This high average price is due to the value placed on the medicinal waters of French Lick. Three new springs joined the list of those reporting sales, the Carlson, Vineland, and Winona Lake, making the total number listed 18. Only about 3 per cent of the water sold was intended for table use. At 8 of the springs are resorts, accommodating nearly 8,000 people, and the water at 6 springs is said to be used for bathing. In addition to the quantity sold, a considerable quantity was stated to be used in the manufacture of soft drinks.

The following springs reported sales:

Blue Cast Magnetic Spring, Woodburn, Allen County.
Blue Lick Spring, Blue Lick, Clark County.
Carlson Mineral Springs, Laporte, Laporte County.
Cartersburg Mineral Spring, Cartersburg, Hendricks County.
Coats Springs, Logan Township, Pike County.
Hunter Mineral Springs, Kramer, Warren County.
King's Mineral Spring, Dallas, Clark County.
Knott's Mineral Spring, Porter, Porter County.
McCullough Spring, Oakland City, Gibson County.
Mineral Spa Lithia Spring, near Richmond, Wayne County.
Mudlavia Lithia Spring, Kramer, Warren County.
Paoli Lithia and Sulphur Springs, Paoli, Orange County.
Pluto, Proserpine, and Bowles Springs, French Lick, Orange County.
Vineland Spring, Terre Haute, Vigo County.
West Baden Mineral Springs, West Baden, Orange County.
White Crane Spring, Dillsboro, Dearborn County.
Winona Lake Springs, Winona Lake, Kosciusko County.

IOWA.

The returns from Iowa show that the output of mineral waters declined in 1909, the sales decreasing 27.42 per cent and the value 54.97 per cent. The total sales reported were 184,000 gallons, valued at $14,116. These figures, compared with the 1908 returns of 253,500 gallons, valued at $31,350, show a falling off of 69,500 gallons in quantity and of $17,234 in value. No new springs reported and the list of producers in the two years was the same. Little of the Iowa mineral water is used for medicinal purposes; there are no resorts at these springs, nor is the water used for bathing. A considerable quantity was stated to have been used in the manufacture of soft drinks.

The 6 reporting springs are:

Colfax Mineral Wells, Colfax, Jasper County.
Council Bluffs Springs, Council Bluffs, Pottawattamie County.
Heston's Springs, Fairfield, Jefferson County.
Manawa Mineral Spring, Storm Lake, Buena Vista County.
Ottumwa Mineral Spring, Ottumwa, Wapello County.
White Sulphur Spring, Linnwood, Scott County.

KANSAS.

According to the reports there was increased activity in the mineral-water trade of Kansas during 1909, the sales increasing 70 per cent and the value 20 per cent. The reported sales amounted to 633,024 gallons, as compared with 370,943 reported in 1908, a gain of 262,081 gallons. The value increased in less ratio, from $74,380 in 1908 to $89,796 in 1909, an increase of $15,416. The average selling prices reported were 20 cents per gallon in 1908 and 14 cents in 1909. Three new springs—the Geyser Mineral, Magnesium and Choteau, and Mission Wells—increased the total number reporting to 19. Medicinal waters made up about three-fourths of the total sales. At 8 of the springs are resorts with total accommodations for about 800 people, and the water at the 8 springs is used for bathing. A large amount of mineral water, separately reported, went into the manufacture of soft drinks.

The following 19 springs reported sales:

Abilena Spring, Willowdale Township, Dickinson County.
Aganippe Spring, near Independence, Montgomery County.
Artesian Pure Spring, near Hutchinson, Reno County.
Blasing's Natural Medical Spring, near Manhattan, Riley County.
Boon Vichy Spring, Topeka, Shawnee County.
California Spring, Ottawa, Franklin County.
Chautauqua Springs, Chautauqua, Chautauqua County.
Crystal Spring, Coffeyville, Montgomery County.
Geuda Springs, Geuda Springs, Cowley County.
Geyser Mineral Springs, Rosedale, Wyandotte County.
Henry Hoover Mineral Spring, Onaga, Pottawatomie County.
Ironton Spring, Wetmore, Nemaha County.
Magnesium and Choteau Springs, Independence, Montgomery County.
Merrill Spring, Carbondale, Osage County.
Mission Wells, Mission, Harvey County.
Phillip's Mineral Spring, Topeka, Shawnee County.
Sun Mineral Spring, Morrill, Brown County.
Sycamore Mineral Spring, Sabetha, Brown County.
Waconda Spring, Waconda Springs, Mitchell County.

KENTUCKY.

The record of the mineral-water trade of Kentucky for 1909 shows a slight falling off in quantity sold, with an increase in the value thereof, the average price advancing 2 cents—from 8 cents in 1908 to 10 cents in 1909. The sales reported amounted to 756,425 gallons, valued at $73,767, a decrease of 40,761 gallons, or 5.11 per cent, in quantity, and an increase of $7,655, or 11.58 per cent, in value. Two new springs were added to the list, the Blue Rock and the Spring Rock Lithia, the total number reporting being 16. The total sales are divided about equally between table and medicinal waters. There are resorts at 4 of the springs with accommodations for about 16,000 people, and the water at 3 is said to be used for bathing.

The 16 reporting springs are as follows:

Anita Springs, La Grange, Oldham County.
Beechwood Springs, Beechwood, Owen County.
Big Bone Spring, Bigbone, Boone County.
Blue Lick Spring, Blue Lick Springs, Nicholas County.
Blue Rock Spring, Fisherville, Jefferson County.
Drennon Springs, Eminence, Henry County.
Glen Lily Spring, near Bowling Green, Warren County.
Hamby's Salts, Iron and Lithia Springs, Dawson Springs, Hopkins County.
Lexington Lithia Springs, Lexington, Fayette County.
Renfro White Sulphur Spring, Lexington, Fayette County.
Robson Spring, Fort Thomas, Campbell County.
Royal Magnesian Spring, near La Grange, Oldham County.
Smith Medical Well, near Kelly, Christian County.
Spring Rock Lithia Spring, Springlake, Kenton County.
Upper Blue Lick Springs, Nicholas County.
White's Diamond Spring, Crab Orchard, Lincoln County.

LOUISIANA.

On the face of the returns, the mineral-water trade made a greater gain in Louisiana than in any other State. The addition of 2 springs to the list of those reporting accounts in part for the increase shown. During 1909 there were 1,375,000 gallons reported sold, valued at $103,850, an increase of 974,500 gallons, or 243 per cent over the reported sales for 1908. The value increased from $52,020 in 1908 to $103,850 in 1909, a gain of $51,830, or 99.63 per cent. The average selling price was 8 cents. The 2 new springs were the Geyser and the Pineland. Practically the entire output was classed as table water. At 2 of the springs are resorts accommodating more than 3,000 people, and the water at 1 is used for bathing. A large quantity, separately reported, was used in the manufacture of soft drinks. The 5 springs that made returns are:

Abita Springs, Abita Springs, St. Tammany Parish.
Geyser Well, Hammond, Tangipahoa Parish.
Krotz Well, Krotz Springs, St. Landry Parish.
Ozone Spring, Covington, St. Tammany Parish.
Pineland Spring, Covington, St. Tammany Parish.

MAINE.

There was a decided increase in the mineral-water output of Maine during 1909. The sales amounted to 1,515,541 gallons, valued at $402,593, as compared with 1,182,322 gallons, valued at $394,346, in 1908, a gain of 333,219 gallons, or 28.18 per cent, in quantity, and of $8,247, or 2.09 per cent, in value. The reported selling price per gallon averaged 33 cents in 1908 and 27 cents in 1909. Nine new springs were listed—the Hanover, Kennebunk Mineral, Minot, Mountain Purity, Mystic, Radio Granite, Redman Farm, Saco, and Virginia—and the total number reported was 33. Only about 4 per cent of the total sales was for medicinal use. The record for the last six years is as follows:

Production and value of mineral waters in Maine, 1904–1909.

Year.	Springs reporting sales.	Quantity sold (gallons).	Value.	Year.	Springs reporting sales.	Quantity sold (gallons).	Value.
1904	23	1,535,955	$428,083	1907	26	1,161,832	$414,300
1905	29	1,167,787	246,159	1908	27	1,182,322	394,346
1906	28	1,368,113	424,678	1909	33	1,515,541	402,593

There are resorts at but 3 of these springs, with total accommodations for about 600 people, and the water at 2 is said to be used for bathing. In addition to the sales given, a considerable amount was used in the manufacture of soft drinks.

The names of the 33 springs listed are:

Bakers Puritan Spring, Old Orchard, York County.
Crystal Mineral Spring, Auburn, Androscoggin County.
Forest Springs, Litchfield, Kennebec County.
Glenrock Mineral Spring, Greene, Androscoggin County.
Glenwood Spring, Augusta, Kennebec County.
Glenwood Spring, St. Albans, Somerset County.
Hanover Spring, Hanover, Oxford County.
Highland Spring, Lewiston, Androscoggin County.
Indian Hermit Spring, Wells, York County.
Jordan Spring, Alfred, York County.
Kennebunk Mineral Spring, Kennebunk, York County.
Keystone Mineral Spring, East Poland, Androscoggin County.
Minot Spring, West Minot, Androscoggin County.
Mountain Purity Spring, Greene, Androscoggin County.
Mount Kebo Spring, Bar Harbor, Hancock County.
Mount Zircon Spring, Milton Plantation, Oxford County.
Mystic Spring, Saco, York County.
Oak Grove Spring, Brewer, Penobscot County.

Pine Spring, Topsham, Sagadahoc County.
Poland Spring, South Poland, Androscoggin County.
Pownal Mineral Spring, New Gloucester, Cumberland County.
Radio Granite Spring, Windham, Cumberland County.
Raymond Spring, North Raymond, Cumberland County.
Redman Farm Spring, Belfast, Waldo County.
Rocky Hill Spring, Fairfield, Somerset County.
Sabattus Mineral Spring, Wales, Androscoggin County.
Saco Spring, Saco, York County.
Seal Rock Spring, Saco, York County.
Skowhegan Crystal Spring, Skowhegan, Somerset County.
Thorndike Mineral Spring, near Thorndike, Waldo County.
Ticonic Mineral Spring, Waterville, Kennebec County.
Virginia Spring, Rumford, Oxford County.
Wawa Lithia Spring, Ogunquit, York County.

MARYLAND.

The mineral-water trade of Maryland made a decided gain during 1909, the sales rising from 806,673 gallons reported in 1908 to 938,496 gallons, an increase of 131,823 gallons, or 16.34 per cent. The value increased in even greater ratio—from $75,858 in 1908 to $91,569 in 1909. According to the returns, the average selling price was 10 cents a gallon. Two new springs reported, the Castalia and the Spaws, the total number reporting being 7. Practically all of the output is classed as table water. There are resorts at 4 of the springs, with accommodations for over 600 people, and the water at 1 is used for bathing. A small quantity was used in the manufacture of soft drinks.

The list of reporting springs follows:

Altamont Spring, near Deer Park, Garrett County.
Buena Vista Spring, Edgemont, Washington County.
Carroll Springs, Forest Glen, Montgomery County.
Castalia Spring, near Branchville, Prince Georges County.
Chattolanee Spring, Chattolanee, Baltimore County.
Mardela Mineral Spring, Mardela, Wicomico County.
Spaws Spring, Easton, Talbot County.

MASSACHUSETTS.

Massachusetts, which leads all the States in the number of commercial mineral springs, reported a substantial increase in the volume of business during 1909. The sales were 5,424,082 gallons, an increase of 23.41 per cent (1,029,033 gallons) over those for 1908. There was but a small increase in the value, the average price per gallon, according to the returns, being 5 cents in 1908 and 4 cents in 1909. The record for the past six years has been as follows:

Production and value of mineral waters in Massachusetts, 1904–1909.

Year.	Springs reporting sales.	Quantity sold (gallons).	Value.	Year.	Springs reporting sales.	Quantity sold (gallons).	Value.
1904	56	5,214,068	$353,485	1907	51	4,661,115	$208,579
1905	59	4,202,263	208,419	1908	61	4,395,049	227,907
1906	53	3,857,955	210,152	1909	60	5,424,082	228,067

Eight new springs were added to the list in 1909, the Chelmsford, Los Altos, Miscoe, Mount Orient, Mount Washington, October, Roberge, and Twin Elm, making the total number reporting 60.

Only a little more than 1 per cent of the total was reported sold for medicinal use. Only 2 springs are resorts, and these resorts have accommodations for about 50 guests. At only 1 spring is the water used for bathing. In addition to the sales given, considerable water was used to manufacture soft drinks. The 60 reporting springs are as follows:

Abbotts Spring, Methuen, Essex County.
Ballardvale Spring, Ballardvale, Essex County.
Belmont Crystal Spring, Belmont, Middlesex County.
Belmont Hill Spring, Everett, Middlesex County.
Burnham Spring, Methuen, Essex County.
Cadwells Crystal Spring, East Woburn, Middlesex County.
Chapmans Crystal Spring, Stoneham, Middlesex County.
Chelmsford Spring, Chelmsford, Middlesex County.
Cold Spring, Randolph, Norfolk County.
Crescent Spring, Brockton, Plymouth County.
Diamond Spring, Lawrence, Essex County.
El-Azhar Spring, Tyngsboro, Middlesex County.
Everett Crystal Spring, Everett, Middlesex County.
Farrington Silver Spring, Milton, Norfolk County.
Fulton Spring, Medford, Middlesex County.
Garfield Spring, Weymouth, Norfolk County.
Goulding Spring, Whitman, Plymouth County.
Granite Rock Spring, Brockton, Plymouth County.
Highland Spring, West Abington, Plymouth County.
Hillcrest Spring, Rowley, Essex County.
Indian Spring, Brockton, Plymouth County.
Katahdin Spring, Lexington, Middlesex County.
King Philip Spring, Mattapoisett, Plymouth County.
Leland Spring, Natick, Middlesex County.
Los Altos Spring, Stoneham, Middlesex County.
Lovers Leap Deep Glen Spring, West Lynn, Essex County.
Massasoit Spring, West Springfield, Hampden County.
Milton Spring, Milton, Norfolk County.
Miscoe Spring, Mendon, Worcester County.
Mount Holyoke Lithia Spring, South Hadley, Hampshire County.
Mount Pleasant Spring, Lowell, Middlesex County.
Mount Orient Spring, West Pelham, Hampshire County.
Mount Vernon Spring, Lawrence, Essex County.
Mount Washington Spring, Chelsea, Suffolk County.
Nemasket Spring, Middleboro, Plymouth County.
Nobscot Mountain Spring, Framingham, Middlesex County.
Norwood Spring, Norwood, Norfolk County.
October Spring, Lenox, Berkshire County.
Pearl Hill Mineral Spring, Fitchburg, Worcester County.
Pepperell Spring, Pepperell, Middlesex County.
Pocahontas Spring, Lynnfield Center, Essex County.
Puritan Spring, Andover, Essex County.
Ravenwood Spring, Gloucester, Essex County.
Robbins Springs, Arlington Heights, Middlesex County.
Roberge Mineral Spring, Worcester, Worcester County.
Rock Spring, Newburyport, Essex County.
Sand Spring, Williamstown, Berkshire County.
Shawmut Spring, West Quincy, Norfolk County.
Simpson Spring, South Easton, Bristol County.
Sippican Spring, Marion, Plymouth County.
Sterling Spring, West Lynn, Essex County.
Stevens Spring, Lawrence, Essex County.
Sunnyside Spring, Franklin, Norfolk County.
Trapelo Spring, Belmont, Middlesex County.
Twin Elm Spring, Lexington, Middlesex County.
Undine Crystal Spring, Brighton, Suffolk County.
Valpey Spring, Lawrence, Essex County.
Whitman Spring, Whitman, Plymouth County.
Wilbraham Mountain Spring, Wilbraham, Hampden County.
Ye Cape Cod Pilgrim Spring, South Wellfleet, Barnstable County.

MICHIGAN.

The returns from Michigan show a large increase in the mineral-water trade of that State during 1909. The figures indicate that 2,760,604 gallons were sold, valued at $104,454, which, when compared with the output in 1908 of 2,004,433 gallons, valued at $88,910, shows a gain of 756,171 gallons, or 37.72 per cent in quantity and of $15,544, or 17.48 per cent in value. The average selling price per gallon in the two years was the same. The following table shows the record for the last six years:

Production and value of mineral waters in Michigan, 1904–1909.

Year.	Springs reporting sales.	Quantity sold (gallons).	Value.	Year.	Springs reporting sales.	Quantity sold (gallons).	Value.
1904	19	3,385,675	$118,422	1907	19	1,472,679	$127,133
1905	17	2,684,800	277,188	1908	24	2,004,433	88,910
1906	19	902,528	73,357	1909	19	2,760,604	104,454

Only 1 new spring reported for 1909, the Lake Superior; the total number making returns was 5 less than in 1908, a number having gone out of business, and 2 refused to report. Less than 1 per cent of the total output was classed as medicinal water. There are resorts at 6 of the springs, accommodating nearly 1,500 people, and the water at 3 is said to be used for bathing. A large quantity not included in the sales was used in the manufacture of soft drinks.

The reporting springs are as follows:

Andrews Magnetic Mineral Spring, St. Louis, Gratiot County.
Arctic Spring, Grand Rapids, Kent County.
Cooper Farm Spring, Birmingham, Oakland County.
Crystal Springs, Grand Rapids, Kent County.
Eastman Springs, Benton Harbor, Berrien County.
Harrison Springs, near Grand Rapids, Kent County.
Lake Superior Mineral Spring, Marquette, Marquette County.
Lansingwald Spring, Grand Rapids, Kent County.
Midland Mineral Spring, Midland, Midland County.
No-Che-Mo Mineral Spring, Reed City, Osceola County.
Ogemaw Spring, Maltby, Ogemaw County.
Ponce de Leon Spring, Paris Township, Kent County.
Royal Oak Spring, Royal Oak, Oakland County.
Salutaris Spring, St. Clair, St. Clair County.
Sanitas Spring, Topinabee, Cheboygan County.
Silver Springs, Grand Rapids, Kent County.
Sterling Spring, Crystal Falls, Iron County.
Victory Spring, Mount Clemens, Macomb County.
White Oak Spring, near Battle Creek, Calhoun County.

MINNESOTA.

In quantity of mineral water sold, Minnesota has held first place for several years, though the number of commercial springs is smaller than in several States of less output. In 1909 there were sold 13,746,142 gallons, a gain of 2,760,606 gallons, or 25.13 per cent over the output reported for 1908. The value increased from $551,986 in 1908 to $614,291 in 1909, a gain of $62,305, or 11.29 per cent.

The average selling price per gallon declined from 5 cents to 4 cents. The record for the last six years has been as follows:

Production and value of mineral waters in Minnesota, 1904–1909.

Year.	Springs reporting sales.	Quantity sold (gallons).	Value.	Year.	Springs reporting sales.	Quantity sold (gallons).	Value.
1904	4	902,500	$21,545	1907	8	9,654,030	$524,800
1905	6	7,681,650	132,970	1908	11	10,985,536	551,986
1906	7	8,621,979	175,677	1909	20	13,746,142	614,291

In 1909 no less than 9 new springs reported for the first time, as follows: Clear, Donaldson's Artesian Well, Fifield Artesian Well, Hillside Crystal, Minnepura, Pokegama, See-L-See, Silver, and Swasteka. The total number to report was 20. The record shows no idle nor delinquent springs in this State. The springs sell table water, less than 1 per cent of the total being used for medicinal purposes. There are no resorts at any of these springs, nor is the water at any used for bathing. A large quantity, separately noted, was used in the manufacture of soft drinks. The list of commercial springs in the State now covers the following names:

Bryn Mawr Spring, Minneapolis, Hennepin County.
Clear Spring, Excelsior, Hennepin County.
Deep Mineral Spring, Crookston, Polk County.
Donaldson Artesian Well, Minneapolis, Hennepin County.
Fifield Artesian Well, Winona, Winona County.
Glenwood-Inglewood Spring, Minneapolis, Hennepin County.
Highland Spring, St. Paul, Ramsey County.
Hillside Crystal Springs, Stillwater, Washington County.
Indian Medical Spring, Elk River, Sherburne County.
Mankota Mineral Springs, near Eagle Lake, Blue Earth County.
Minnepura Spring, Sandstone, Pine County.
Owatonna Vichy Spring, Owatonna, Steele County.
Owens Spring, Glenwood, Pope County.
Pokegama Spring, near Detroit, Becker County.
Red Star Spring, Cold Spring, Stearns County.
Rock Spring, Shakopee, Scott County.
See-L-See Spring, Hibbing, St. Louis County.
Silver Spring, Marshall, Lyon County.
Swasteka Spring, Cold Spring, Stearns County.
Trio Siloam Spring, Austin, Mower County.

MISSISSIPPI.

Returns from Mississippi indicate an increase in the mineral-water trade of that State during 1909, sales advancing from 257,200 gallons in 1908 to 307,315 gallons in 1909, a gain of 50,115 gallons, or 19.48 per cent. The increase in the value was small because of the lower average selling price, which was 17 cents, as against 21 cents in 1908. Three springs reported sales for the first time, the Iuka Mineral, the St. Roch, and the Saratoga, increasing the total number listed to 9. Nearly four-fifths of the total output is used for medicinal purposes. There are resorts at 6 springs, with accommodations for over 2,000 people, and at 2 springs the water is said to be used for bathing. In addition to the sales reported, a considerable amount of water was used in the manufacture of soft drinks.

The 9 reporting springs are given below:

Arundel Lithia Spring, near Meridian, Lauderdale County.
Browns Wells, near Hazelhurst, Copiah County.
Castalian Spring, near Durant, Holmes County.
Iuka Mineral Springs, Iuka, Tishomingo County.
Lauderdale Spring, Lauderdale, Lauderdale County.
Robinson Springs, near Pocahontas, Hinds County.
St. Roch Spring, Bay St. Louis, Hancock County.
Saratoga Springs, Saratoga, Simpson County.
Stafford Mineral Springs, Vossburg, Jasper County.

MISSOURI.

According to statements received from spring owners in Missouri, the output, 765,032 gallons, was 82,211, or 12.04 per cent greater for 1909 than for 1908. The value increased in even greater ratio—from $86,043 in 1908 to $111,448 in 1909, a gain of $25,405, or 29.53 per cent. The average selling price rose from 13 cents to 15 cents. Five new springs made returns as follows: Carrollton, Old Orchard, Thespian, White, and Wyaconda. The total number reporting was 28, however, 2 less than for 1908, several springs having gone out of business and 2 declining to report. About two-thirds of the total output is said to be used medicinally. At 7 of these springs are resorts accommodating in all about 10,000 people, and the water at 8 springs is used for bathing. In addition to the sales reported, a large quantity was used in the manufacture of soft drinks.

The following springs made returns of sales:

American Spring, St. Louis, St. Louis City County.
Belcher Artesian Well, St. Louis, St. Louis City County.
Blue Lick Springs, Blue Lick, Saline County.
Bokert Springs, near De Soto, Jefferson County.
Bowling Green Mineral Spring, near Bowling Green, Pike County.
Carrollton Mineral Spring, Carrollton, Carroll County.
Crystal Lithium Spring, Excelsior Springs, Clay County.
Cusenbary Spring, near Kansas City, Jackson County.
El Dorado Springs, Eldorado Springs, Cedar County.
Haymaker Spring, Mercer County, near Lineville, Iowa.
Hornet Mineral Springs, Bowling Green, Pike County.
Jackson Lithia Spring, Mount Washington, Jackson County.
Kalinat and Ionian Lithia Springs, near Bowling Green, Pike County.
McAllister Springs, McAllister Springs, Saline County.
Nek-Roc Spring, Burlington Junction, Nodaway County.
Old Orchard Spring, Old Orchard, St. Louis County.
Regent, Siloam, Soterian, and Sulpho-Saline Springs, Excelsior Springs, Clay County.
Salt Sulphur Well, Excelsior Springs, Clay County.
Sparkling Lithia Well, Excelsior Springs, Clay County.
Sweet Springs, Sweet Springs, Saline County.
Thespian Spring, Louisiana, Pike County.
Tootle Mineral Spring, Halls, Buchanan County.
White Springs, Independence, Jackson County.
Windsor Spring, Windsor, Henry County.
Wyaconda Spring, Lagrange, Lewis County.

MONTANA.

Two springs reported sales in 1909, compared with 1 in 1908, and the new spring was responsible for much of the increased output. All of the water from both these springs is used for the table. The figures of output are included with those of other States having less than three producers. The 2 springs are:

Lissner's Mineral Spring, Helena, Lewis and Clark County.
Rock Creek Spring, Red Lodge, Carbon County.

NEBRASKA.

Only 1 spring, and that a new one, reported during 1909, all the other springs that have made reports being idle or delinquent. The water of this spring is used for both table and medicinal purposes, and in the manufacture of soft drinks. The name of the spring is:

Curo Mineral Spring, South Omaha, Douglas County.

NEW HAMPSHIRE.

The output of mineral waters in New Hampshire showed an increase from 835,349 gallons sold in 1908 to 934,072 gallons sold in 1909, a gain of 98,723 gallons, or 11.82 per cent. The value increased from $235,520 to $245,607, an increase of $10,087, or 4.28 per cent. The average selling price per gallon was 26 cents; in 1908 it was 28 cents. Only 1 new spring reported, the Mount Gunstock. The total number to report was 10. The New Hampshire mineral water is said to be used principally for medicinal purposes. One of the springs is a resort, but at none is the water used for bathing. A considerable quantity of water was used in the manufacture of soft drinks. The 10 reporting springs are:

Cohas Spring, Londonderry, Rockingham County.
Granite State Spring, Plaistow, Rockingham County.
Lafayette Mineral Spring, Derry, Rockingham County.
Londonderry Lithia Well, Londonderry, Rockingham County.
Mount Gunstock, Lake Shore Park, Belknap County.
Mount Madison Spring, Gorham, Coos County.
Pack Monadnock Lithia Spring, Temple, Hillsboro County.
White Mountain Mineral Spring, Conway, Carroll County.
Willow Spring, South Nashua, Hillsboro County.
Wilton Mineral Spring, near Wilton, Hillsboro County.

NEW JERSEY.

In New Jersey the mineral-water trade continued to prosper, the output increasing 18.39 per cent and the value 0.33 per cent. The sales reported for 1909 were 1,419,500 gallons, valued at $127,025, compared with 1,199,023 gallons, valued at $126,603, an increase of 220,477 gallons in quantity and of $422 in value. The average selling price was 9 cents, compared with 11 cents in 1908. The record for the last six years has been as follows:

Production and value of mineral waters in New Jersey, 1904–1909.

Year.	Springs reporting sales.	Quantity sold (gallons).	Value.	Year.	Springs reporting sales.	Quantity sold (gallons).	Value.
1904	9	188,450	$24,870	1907	11	982,445	$103,082
1905	10	394,060	45,397	1908	13	1,199,023	126,603
1906	9	585,215	65,186	1909	11	1,419,500	127,025

No new springs made returns for 1909, and the total number reporting was 2 less than for 1908. Practically the entire output is classed as table water, and none of the springs is a resort. A considerable quantity of spring water was used for soft drinks. The following springs made returns of sales:

Alpha Mineral Spring, Springfield, Union County.
Culm Rock Spring, Pluckemin, Somerset County.
Indian Spring, near Rockaway, Morris County.
Kalium Spring, Collingswood, Camden County.
Kanouse-Oakland Spring, Oakland, Bergen County.
Mount Tabor Spring, Mount Tabor, Morris County.
Pilgrim Spring, Ridgefield Park, Bergen County.
Red Rock Spring, Spring Valley Road, Bergen County.
Trinity Springs, Ridgefield, Bergen County.
Washington Rock Spring, Warrenville, Somerset County.
Watchung Spring, North Plainfield, Union County.

NEW MEXICO.

There was a slight increase in the sales of mineral water during 1909, from 152,200 gallons to 157,700 gallons, a gain of 5,500 gallons, or 3.61 per cent. Owing to the higher selling prices reported the value rose $12,779, or 79.57 per cent. The average selling price per gallon was 18 cents. No new springs reported, and the total listed was the same as in 1908. The output is said to be about equally divided between medicinal and table waters. There are resorts at 3 of the springs with accommodations for over 200 people, and at 3 springs the water is used for bathing. None of the springs reported any water used in the manufacture of soft drinks. Returns were received from the following 6 springs:

Aztec Spring, Taylor, Colfax County.
Carlsbad Mineral Spring, Carlsbad, Eddy County.
Coyote Springs, Albuquerque, Bernalillo County.
Faywood Hot Spring, Faywood, Grant County.
Macbeth Spring, near East Las Vegas, San Miguel County.
Ojo Caliente Spring, Ojo Caliente, Taos County.

NEW YORK.

The mineral-water output of New York during 1909 increased about 10 per cent in quantity and value, and the State ranked second in volume of sales, being exceeded only by Minnesota. The sales reported were 8,813,563 gallons, valued at $948,325, compared with 8,007,092 gallons, valued at $855,148, in 1908. These figures show a gain in quantity of 806,471 gallons, or 10.07 per cent, and in value of $93,177, or 10.90 per cent. The average selling price was the same for the two years. The record for the last six years has been as follows:

Production and value of mineral waters in New York, 1904-1909.

Year.	Springs reporting sales.	Quantity sold (gallons).	Value.	Year.	Springs reporting sales.	Quantity sold (gallons).	Value.
1904	41	6,352,517	$783,244	1907	41	7,176,815	$686,574
1905	40	5,619,878	652,680	1908	47	8,007,092	855,148
1906	42	6,481,074	893,476	1909	52	8,813,563	948,325

Eight springs that made no returns in 1908 reported in 1909. These were the Franklin Lithia, Ithaca, Mammoth, Parker Crystal, Saratoga Gurn, Sparkling, Standard, and White Sulphur. The total number reporting was 52. About 20 per cent of the total output is said to be used medicinally. At 7 of the springs are resorts accommodating over 6,000 people, and at 3 the water is used for bathing. A considerable quantity of water, reported separately, was used for the manufacture of soft drinks. The 1909 list of commercial springs is as follows:

Artesian Lithia Spring, Ballston Spa, Saratoga County.
Artesian Natural Mineral Spring, Franklin Springs, Oneida County.
Baldwin Mineral Spring, Cayuga, Cayuga County.
Breesport Spring, Breesport, Chemung County.
Briarcliff Spring, Briarcliff Manor, Westchester County.
Chautauqua Spring, Westfield, Chautauqua County.
Chemung Spring, Chemung, Chemung County.
Chemung Valley Spring, Elmira, Chemung County.
Cold Springs, New Hartford, Oneida County.
Crystal Springs, near Oswego, Oswego County.
Deep Rock Spring, Oswego, Oswego County.
Diamond Rock Spring, Cherry Creek, Chautauqua County.
Elixir Spring, Clintondale, Ulster County.
Elk Spring, Oswego, Oswego County.
Franklin Lithia Spring, Franklin Springs, Oneida County.
Geneva and Red Cross Mineral Springs, Geneva, Ontario County.
Gramatan Spring, Bronxville, Westchester County.
Great Bear Spring, near Fulton, Oswego County.
Hide Franklin Spring, Ballston Spa, Saratoga County.
Ithaca Well, Ithaca, Tompkins County.
Kirkland Spring, Franklin Springs, Oneida County.
Mammoth Spring, North Greenbush, Rensselaer County.
Massena Mineral Spring, Massena Springs, St. Lawrence County.
Monarch Spring, Matteawan, Dutchess County.
Mount Beacon Spring, near Matteawan, Dutchess County.
Mount View Spring, Poughkeepsie, Dutchess County.
Parker Crystal Spring, Rome, Oneida County.
Pleasant Valley Spring, Rheims, Steuben County.
Putnam Spring, near Peekskill, Westchester County.
Red Jacket Mineral Spring, Seneca Falls, Seneca County.
Redstone Mineral Spring, Oswego, Oswego County.
Saratoga Springs, Saratoga County:
- Arondack Spring.
- Chief Spring.
- Congress Spring.
- Geyser Spring.
- Hathorn Spring.
- High Rock Spring.
- Patterson Spring.
- Saratoga Carlsbad Spring.
- Saratoga Gurn Spring.
- Saratoga Seltzer and Emperor Spring.
- Star Spring.

Setauket Spring, Setauket, Suffolk County.
Shell Rock Spring, near Rensselaer, Rensselaer County.
Sparkling Spring, Buffalo, Erie County.
Split Rock Spring, Franklin Springs, Oneida County.
Standard Spring, Troy, Rensselaer County.
Sun-Ray Spring, Ellenville, Ulster County.
Vita Spring, Fort Edward, Washington County.
White Sulphur Spring, Richfield Springs, Otsego County.
White Sulphur Spring, Sharon Springs, Schoharie County.

NORTH CAROLINA.

Owing to the smaller number of springs reporting sales, the total output and the value were less in 1909 than in 1908. The sales reported by spring owners amounted to 128,171 gallons, valued at $20,558, against 160,195 gallons, valued at $27,163, reported in 1908, a loss of 32,024 gallons, or 19.99 per cent, in quantity, and of $6,605, or 24.32 per cent, in value. The average selling price decreased from 17 cents to 16 cents. Three new springs reported—the Huckleberry, Kuidene, and Rocky River. The total number reporting was 15, or 3 less than in 1908. Several were idle or out of business, and 2 declined to make returns. The greater part of the water sold is used medicinally. At 9 of the springs are resorts, accommodating nearly 1,500 people, and the water at 2 is used for bathing. Only a small quantity was reported used in the manufacture of soft drinks. The following springs made returns of sales for 1909:

All Healing Spring, Alkalithia Springs, Alexander County.
Buckhorn Lithia Spring, Bullock, Granville County.
Derita Mineral Spring, near Derita, Mecklenburg County.
Hot Springs, Hot Springs, Madison County.
Huckleberry Spring, Durham, Durham County.
Jackson Springs, Jackson Springs, Moore County.
Kuidene Spring, Polk County.
Mida Spring, near Charlotte, Mecklenburg County.
Moore's Springs, Moores Springs, Stokes County.
Mount Vernon Springs, Mount Vernon Springs, Chatham County.
Rocky River Springs, Rocky River Springs, Anson County.
Seven Springs, Seven Springs, Wayne County.
Sherrill Mineral Spring, near Harrisburg, Cabarrus County.
Smith Lithia Spring, Oxford, Granville County.
Vade Mecum Spring, Vade Mecum, Stokes County.

NORTH DAKOTA.

Only one commercial spring reported from North Dakota, the same one that reported in 1908. This spring is not a resort, but sells considerable water for table use, and also uses a small quantity in the manufacture of soft drinks. This spring is:

Gordon Spring, Michigan, Nelson County.

OHIO.

The output of mineral water in Ohio during 1909 continued to advance, the figures showing a gain of 299,462 gallons, or 12.43 per cent, over 1908. The reported output was 2,709,060 gallons, but owing to the lower average price per gallon the value was $112,775, a decline of 9.74 per cent. The figures for the last six years compare as follows:

Production and value of mineral waters in Ohio, 1904–1909.

Year.	Springs reporting sales.	Quantity sold (gallons).	Value.	Year.	Springs reporting sales.	Quantity sold (gallons).	Value.
1904	13	3,223,958	$306,566	1907	24	1,536,621	$121,531
1905	23	943,114	117,733	1908	27	2,409,598	124,938
1906	27	1,790,767	164,007	1909	31	2,709,060	112,775

There were 7 new springs reporting in 1909 for the first time, as follows: Alba, Chalybeate, Crystal Fountain, Highland, Oak Place, Peerless, and Puritas, the total number reporting increasing to 31, a gain of 4 over the previous year. Only about 20 per cent of the total output is used medicinally. There are resorts at 5 of the springs, with accommodations for about 600 people, and the water at 3 is said to be used for bathing. A considerable quantity was also used in the manufacture of soft drinks.

The 31 reporting springs are as follows:

Alba Spring, Rockport, Cuyahoga County.
Beech Rock Spring, near Zanesville, Muskingum County.
Bellmore Springs, near Signal, Columbiana County.
Belmont Spring, Bridgeport, Belmont County.
Cedar Spring, New Paris, Preble County.
Chalybeate Spring, Newark, Licking County.
Collingwood Springs, Toledo, Lucas County.
Crum Mineral Spring, Austintown, Mahoning County.
Crystal Fountain Springs, Plainville, Hamilton County.
Deerfield Spring, Deerfield, Portage County.
Fargo Mineral Spring, Ashtabula, Ashtabula County.
Highland Springs, Akron, Summit County.
Jefferson and Benson Springs, Bloom Township, Fairfield County
Maple Grove Mineral Spring, near Chillicothe, Ross County.
Oak Place Spring, Akron, Summit County.
Oak Ridge Mineral Springs, Greenspring, Sandusky County.
Painesville Mineral Spring, Painesville, Lake County.
Peerless and Puritas Springs, West Park, Cuyahoga County.
Providence Spring, Columbus, Franklin County.
Quakerdale Spring, Colerain, Belmont County.
Reynold's Artesian Well, Greenspring, Sandusky County.
Ripley Bromo Lithia Spring, Ripley, Brown County.
Sandrock Spring, Canton, Stark County.
Schoenbrun Spring, near New Philadelphia, Tuscarawas County.
Spark Mineral Spring, Bryan, Williams County.
Spring Grove Mineral Spring, Springfield, Clark County.
Sulphur Lick Spring, near Chillicothe, Ross County.
Tallewanda Mineral Spring, College Corner, Preble County.
Wheeler Mineral Spring, Youngstown, Mahoning County.
Wood's Lithia Spring, near Bridgeport, Belmont County.

OKLAHOMA.

Returns from spring owners in Oklahoma show only a small increase in sales, about 5 per cent in 1909. The output in 1909 amounted to 563,475 gallons, valued at $35,194, against 534,114 gallons, valued at $52,779, in 1908. The average selling price per gallon in 1908 and 1909 was 10 cents and 6 cents, respectively. Four new springs made returns of sales in 1909, the Brow & Eaton, Kalium, Old Government, and Tulsa, and the total number reporting was 12 About two-thirds of the total output is used for the table. There are resorts at 5 of the springs, said to accommodate over 18,000 people, and the water at 6 is used for bathing. A small quantity was used in the manufacture of soft drinks. The following springs reported sales:

Beach Wells, Sulphur, Murray County.
Brow & Eaton Wells, Claremore, Rogers County.
Claremore Radium Wells, Claremore, Rogers County.
Germicide Well, Wagoner, Wagoner County.
Green Well, near Chelsea, Rogers County.
Harper Artesian Bromide Well, Sulphur, Murray County.
Kalium Spring, Faxon, Comanche County.
Lewis Lithia Wells, Oklahoma City, Oklahoma County.
Nowata Radium Well, Nowata, Nowata County.
Old Government Springs, Enid, Garfield County.
Osage Spring, Tulsa, Tulsa County.
Tulsa Crystal Spring, Tulsa, Tulsa County.

OREGON.

Sales of mineral water in 1909 amounted to 41,100 gallons, valued at $10,720, as compared with 25,350 gallons, valued at $8,830, a gain of 15,750 gallons, or 62.13 per cent, in quantity, and of $1,890, or 21.40 per cent, in value. Only 1 new spring reported, the Calapooya, making the total 4, as against 6 reporting in 1908. About two-fifths of the total output is used medicinally. There are resorts at 3 of the springs, accommodating about 100 people, and at 2 the water is used for bathing. Only a small amount was reported used in the manufacture of soft drinks.

The 4 reporting springs are as follows:

Calapooya Spring, London, Lane County.
Cascade Mineral Spring, Cascadia, Linn County.
Colestin Spring, Colestin, Jackson County.
Wagner's Spring, Soda Springs, Jackson County.

PENNSYLVANIA.

There was a large increase in the reported output of mineral waters from Pennsylvania during 1909, this increase being largely due to sales from new springs. Sales increased from 1,430,489 gallons in 1908 to 2,177,967 gallons in 1909, a gain of 747,478 gallons, or 52.25 per cent. The value also increased from $180,889 to $240,856, a gain of $59,967, or 33.15 per cent. No less than 11 new springs made returns, as follows: Cold, Crystal Mineral, Glendale, Keystone, Jeny-See, Massassauga, Mount Laurel, Mount Royal, Ponce de Leon, Sizerville Magnetic, and Thurston Carbonate, increasing the total number reporting to 42. The record for the last six years has been as follows:

Production and value of mineral waters in Pennsylvania, 1904–1909.

Year.	Springs reporting sales.	Quantity sold (gallons).	Value.	Year.	Springs reporting sales.	Quantity sold (gallons).	Value.
1904	21	743,050	$90,465	1907	28	1,287,063	$235,807
1905	27	1,322,594	194,113	1908	32	1,430,489	180,889
1906	27	1,506,286	280,054	1909	42	2,177,967	240,856

About one-third of the total output is used medicinally. There are resorts at 12 of the springs, with accommodations for about 4,000 people, and the water at 6 is said to be used for bathing purposes. In addition to the water sold as water, 531,100 gallons were used in the manufacture of soft drinks.

The following 42 springs reported sales:

Bedford Chalybeate Spring, near Bedford, Bedford County.
Bedford Mineral Spring, near Bedford, Bedford County.
Brookside Spring, Wilkinsburg, Allegheny County.
Bruce Subrock Spring, Pittsburg, Allegheny County.
Carnegie Alkaline and Lithia Mineral Spring, Carnegie, Allegheny County.
Cloverdale Lithia Spring, near Newville, Cumberland County.
Cold Spring, Outwood, Lebanon County.
Colvin's White Sulphur Spring, Sulphur Springs, Bedford County.
Crystal Mineral Springs, Newcastle, Lawrence County.
De Profundis Spring, Saegertown, Crawford County.
De Vita Mineral Spring, Cambridge Springs, Crawford County.
East Mountain Lithia Spring, near Factoryville, Wyoming County.
Ephrata Mountain Crystal Spring, near Ephrata, Lancaster County.
Glendale Spring, East Borro, Lawrence County.

Glen Summit Spring, Glen Summit Springs, Luzerne County.
Granny Coon Spring, North Point, Indiana County.
Gray Mineral Spring, Cambridge Springs, Crawford County.
Harrison Valley Mineral Spring, Harrison Valley, Potter County.
Hiawatha Spring, Mount Hope, Lancaster County.
Kecksburg Artesian Mineral Spring, Kecksburg, Westmoreland County.
Keystone Spring, near Taylorsville, Bucks County.
Jeny See Spring, Genesee, Potter County.
Lang Spring, Venango, Crawford County.
Magnesia Springs, Cambridge Springs, Crawford County.
Massassauga Mineral Spring, Erie, Erie County.
Mount Laurel Spring, Temple, Berks County.
Mount Royal Springs, Shaler Township, Allegheny County.
Pavilion Spring, Wernersville, Berks County.
Petticord Spring, Cambridge Springs, Crawford County.
Pocono Mineral Spring, near Wilkesbarre, Luzerne County.
Polar Springs, Morrisville, Bucks County.
Ponce de Leon Mineral Spring, Meadville, Crawford County.
Pulaski Spring, Pulaski, Lawrence County.
Ross-Common Spring, Ross-Common, Monroe County.
Seely Spring, Salem Township, Luzerne County.
Shohola Spring, Walker Lake, Pike County.
Sizerville Magnetic Spring, Sizerville, Cameron County.
Thurston's Carbonate Spring, West Mead Township, Crawford County.
Tuckahoe Mineral Spring, near Northumberland, Northumberland County.
Whann Lithia Spring, Franklin, Venango County.
White House Spring, Neversink Mountain, Berks County.
Wilson Spring, Mount Pocono, Monroe County.

RHODE ISLAND.

There was no change in the list of commercial springs during 1909, the same 9 springs reporting as for 1908. There was, however, a decline in the volume of business, the sales decreasing from 594,208 gallons in 1908 to 502,970 gallons in 1909, a loss of 91,238 gallons, or 15.36 per cent. This decline was partly the result of the better quality of the municipal supplies at one or two cities. The estimated value also decreased from $39,405 to $35,438, a loss of $3,967, or 10.07 per cent. The average selling price was the same as in 1908. The entire output was used for the table. There are no resorts at any of the Rhode Island springs, nor is the water at any used for bathing. The 9 reporting springs are as follows:

Banner, Cranston, Providence County.
Berry Spring, Pawtucket, Providence County.
Crown Spring, East Providence, Providence County.
Girard Spring, North Providence, Providence County.
Gladstone Spring, Narragansett Pier, Washington County.
Holly Mineral Spring, East Woonsocket, Providence County.
Ochee Spring, Johnston, Providence County.
Prophet Spring, near Providence, Providence County.
Sockanosset Spring, Cranston, Providence, Providence County.

SOUTH CAROLINA.

The returns from this State are notable in showing a decided gain in output. The reported output amounted to 372,880 gallons, indicating a gain of 101,308 gallons, or 37.30 per cent, over the figures reported for 1908 of 271,572 gallons. The value also increased at about the same ratio, the average selling price remaining the same. Two new springs reported for the first time, the Lipscomb Silica and the Steele's Mineral, making the total number reporting 15. Nearly 60 per cent of the total output is used for medicinal purposes. There are resorts at 4 of the springs, accommodating nearly 1,000 people. A comparatively large quantity was used in the manufacture of soft drinks. The 15 reporting springs are as follows:

Antley Springs, St. Matthews, Calhoun County.
Bryan Springs, Young Island, Colleton County.
Buffalo Lick Springs, Carlisle, Union County.
Charleston Artesian Well, Charleston, Charleston County.
Cherokee Spring, Spartanburg, Spartanburg County.
Chick Springs, Chick Springs, Greenville County.
Cokesbury Sulphur Spring, near Cokesbury, Greenwood County.
Glenn Springs, Glenn Springs, Spartanburg County.
Glowing Springs, Dresden, Abbeville County.
Harris Lithia Spring, Harris Springs, Laurens County.
Lipscomb Silica Springs, Gaffney, Cherokee County.
Rives Mineral Spring, near Lancaster, Lancaster County.
Steele's Mineral Spring, Rock Hill, York County.
Verner Spring, Greenville, Greenville County.
White Stone Spring, White Stone Springs, Spartanburg County.

SOUTH DAKOTA.

There was no change in the list of mineral springs during 1909, the same 3 springs reporting as for the previous year. The output, however, declined to a considerable extent. There is a resort at one of the springs where the water is also used for bathing, and at 2 of the springs a considerable quantity of water is used for the manufacture of soft drinks.

The 3 reporting springs are as follows:

Minnehaha Springs, Sioux Falla, Minnehaha County.
Minnekahta Spring, Hot Springs, Fall River County.
Siloam Mineral Spring, Hot Springs, Fall River County.

TENNESSEE.

Returns from spring owners in Tennessee indicate that 1909 was a prosperous year for the mineral-water trade. The sales amounted to 934,912 gallons, valued at $76,185, compared with 712,912 gallons, valued at $60,893, in 1908, a gain in quantity of 222,000 gallons, or 31.14 per cent, and in value of $15,292, or 25.11 per cent. The average selling price was the same in the two years. Four new springs were added to the list, as follows: Cave, Galbraith Epsom Lithia, Thompson, and Hamilton, making the total number reporting 18. About 85 per cent of the total output is used for medicinal purposes. There are resorts at 11 of these springs, with total accommodations for about 2,000 people, and the water at 6 is said to be used for bathing purposes.

The 18 reporting springs are as follows:

Cave Spring, Soddy, Hamilton County.
Deep Cave Mineral Well, Eastland, Davidson County.
East Brook Springs, Cumberland Mountains, Franklin County.
Galbraith Epsom Lithia Springs, Galbraith Springs, Hawkins County.
Gammons Spring, near Tate Spring, Grainger County.
Hamilton Springs, near Lebanon, Wilson County.
Horn Springs, Horn Springs, Wilson County.
Idaho Springs, near Clarksville, Montgomery County.
Montvale Spring, Mint, Blount County.
Pioneer Lithia Spring, near Nashville, Davidson County.
Red Boiling Springs, Redboiling Springs, Macon County.
Rhea Springs, Rhea Springs, Rhea County.
Richardsons Lockeland Spring, near Nashville, Davidson County.
Tate Spring, Tate Springs, Grainger County.
Thompson Spring, near Nashville, Davidson County.
Whittle Springs, Whittle Springs, Knox County.
Willow Brook Spring, Craggie Hope, Cheatham County.
Wright's Epsom-Lithia Spring, Mooresburg, Hawkins County.

TEXAS.

Returns from Texas indicated a considerable falling off in the volume of business in 1909, the sales decreasing to the extent of 34.86 per cent and the value at about the same ratio. The output reported was 1,033,476 gallons, valued at $98,499, as compared with 1,586,634 gallons, valued at $151,032, in 1908. The average price remained the same. The following tables show the statistics of production for the past 6 years:

Production and value of mineral waters in Texas, 1904–1909.

Year.	Springs reporting sales.	Quantity sold (gallons).	Value.	Year.	Springs reporting sales.	Quantity. sold (gallons).	Value.
1904	14	1,142,500	$64,923	1907	23	1,146,279	$152,233
1905	28	1,526,970	144,421	1908	36	1,586,634	151,032
1906	28	1,045,315	122,085	1909	34	1,033,476	98,499

Six new springs were added in 1909, as follows: Aqua Vitæ, Capps Wells, North Park Mineral Well, Orono, Putnam Mineral Well, and Riviere Wells, the total number reporting being 34, a decrease of 2 from the previous year. More than half of the total output is used medicinally. There are resorts at 13 of the springs, with total accommodations for nearly 8,000 people, and the water at 9 is said to be used for bathing. A considerable quantity of water was used in the manufacture of soft drinks.

The following springs reported sales:

Aqua Vitae Wells, Nacogdoches, Nacogdoches County.
Brock's Mineral Well, near Denton, Denton County.
Capp's Wells, Longview, Gregg County.
Dullnig Mineral Well, near San Antonio, Bexar County.
Edward's Well, Weatherford, Parker County.
Farrier Spring, Dalby Springs, Bowie County.
Georgetown Mineral Wells, Georgetown, Williamson County.
Ghio Spring, Texarkana, Bowie County.
Haskell Mineral Wells, Haskell, Haskell County.
High Island Mineral Well, High Island, Galveston County.
Key's Wells, Salado, Bell County.
Love Mineral Well, Weatherford, Parker County.
Marlin Hot Wells, Marlin, Falls County.
Mineral Wells, Palo Pinto County:
    Austin Well.
    Barber Wells.
    Congress Well.
    Crazy Well.
    Gibson Well.
    Indian Well.
    Lamar Well.
    Min-Ala Well.
    Star Well.
    Texas Carlsbad Well.
North Park Mineral Well, Abilene, Taylor County.
Orono Mineral Spring, Oran, Palo Pinto County.
Putnam Mineral Well, Putnam, Callahan County.
Red Mineral Springs, Mount Pleasant, Titus County.
Riviere Wells, 1, 2, and 3, Tyler, Smith County.
Roach Well, near Mount Pleasant, Titus County.
Rosborough Spring, near Marshall, Harrison County.
Texarkana Lonestar Well, near Texarkana, Bowie County.
Tioga Mineral Wells, Tioga, Grayson County.
Woodward Vichy Spring, Woodward, Lasalle County.
X-Ray Spring, Whitesboro, Grayson County.

UTAH.

Only 1 spring reports sales for Utah. This spring is not a resort, but considerable water is sold for medicinal use. The spring is:

Deseret Lithia Spring, Deseret, Millard County.

VERMONT.

Two springs that sold water in 1908 sold none in 1909, and there was a decided falling off in the mineral-water trade in Vermont. The sales reported were 66,100 gallons, valued at $13,326, against 107,800 gallons, valued at $16,380, a decrease of 41,700 gallons, or 38.68 per cent, in quantity, and of $3,054, or 18.64 per cent, in value. The average selling price rose from 15 cents to 20 cents. There were no new springs, and 2 of those reporting in 1908 were idle in 1909. Nearly three-fourths of the output was used for the table. There are resorts at 2 of the springs, accommodating approximately 300 people, and the water at 2 is used for bathing. A considerable quantity was used in 1909 in the manufacture of soft drinks.

The following 3 springs made returns of sales:

Brunswick Sulphur Springs, Brunswick, Essex County.
Clarendon Spring, Clarendon Springs, Rutland County.
Equinox Spring, Manchester, Bennington County.

VIRGINIA.

Although several new springs reported sales in 1909, the total quantity of water reported sold was less than in 1908. Part of this decline resulted no doubt from the improved quality of the municipal supplies of several cities. According to the returns there were sold during the year 1,504,530 gallons, indicating a loss of 505,084 gallons, or 25.13 per cent, from the figures reported for the previous year of 2,009,614 gallons. There was only a slight decrease in the value of the output, the average selling price reported being 4 cents higher than in 1908. The following table shows the statistics of output for the last six years:

Production and value of mineral waters in Virginia, 1904–1909.

Year.	Springs reporting sales.	Quantity sold (gallons).	Value.	Year.	Springs reporting sales.	Quantity sold (gallons).	Value.
1904	35	2,117,420	$281,998	1907	44	2,442,075	$431,770
1905	37	2,340,287	549,102	1908	46	2,009,614	207,115
1906	43	1,997,207	418,908	1909	49	1,504,530	203,455

The 7 new springs were as follows: Alexandria Well, Carper Lithia, Pantops Mountain, Rockbridge Alum, Smithfield Artesian Well, Tripho-Lithia, and White Rock Mineral, the total number reporting being 49. The output is about equally divided between medicinal and table waters. There are resorts at 17 of the springs with accommodations for about 3,500 people, and the water at 8 is said to be used for bathing purposes. A considerable quantity was also used in the manufacture of soft drinks.

The following springs reported sales:

Alexandria Well, Alexandria, Alexandria County.
Alleghany Spring, Alleghany Spring, Montgomery County.
Basic Spring, Basic City, Augusta County.
Bath Alum Springs, McClung, Bath County.
Bear Lithia Spring, near Elkton, Rockingham County.
Beaufont Spring, near Manchester, Chesterfield County.
Bellfont Lithia Spring, near Manchester, Chesterfield County.
Berry Hill Mineral Spring, near Elkwood, Culpeper County.
Blue Ridge Springs, near Blue Ridge Springs, Botetourt County.
Buckhead Lithia Spring, Buckhead Springs, Chesterfield County.
Burnetts Spring, Hudson Mill, Culpeper County.
Brugh's Spring, Botetourt County.
Campfield Lithia Spring, Chesterfield County.
Carper Lithia Springs, Bradford, Montgomery County.
Como Lithia Spring, East Richmond, Henrico County.
Coppahaunk Lithia Springs, Waverly, Sussex County.
Crockett Arsenic Lithia Spring, Crockett Springs, Montgomery County.
Days Point Artesian Lithia Spring, Days Point, Isle of Wight County.
Erup Mineral Spring, near Glencarlyn, Alexandria County.
Farmville Lithia Springs, Farmville, Cumberland County.
Fonticello Lithia Spring, near Manchester, Chesterfield County.
Harris Anti-Dyspeptic Spring, Burkeville, Nottoway County.
Holly Lithia Springs, near Swansboro, Chesterfield County.
Iron-Lithia Springs, Tip Top, Tazewell County.
Jeffress Spring, Jeffress, Mecklenburg County.
Jordan White Sulphur Spring, Stephenson, Frederick County.
Kayser Lithia Springs, Staunton, Augusta County.
Lone Jack Spring, near Lone Jack Station, Campbell County.
Massanetta Spring, Penn Laird, Rockingham County.
Mecklenburg Spring, Chase City, Mecklenburg County.
Mulberry Island Lithia Well, Mulberry Island, Warwick County.
Nye Lithia Springs, Wytheville, Wythe County.
O'Connell Lithia Spring, near Staunton, Augusta County.
Otterburn Lithia Spring, near Amelia, Amelia County.
Paeonian Spring, Paeonian Springs, Loudoun County.
Pantops Mountain Spring, Charlottesville, Albemarle County.
Roanoke Lithia Spring, near Roanoke, Roanoke County.
Rockbridge Alum Springs, Rockbridge Alum Springs, Rockbridge County.
Rubino Healing Springs, Healing Springs, Bath County.
Seawright Spring, near Staunton, Augusta County.
Smithfield Artesian Well, Smithfield, Isle of Wight County.
Stribling Springs, Stribling Springs, Augusta County.
Tripho-Lithia Spring, Claremont, Surry County.
Virginia Etna Springs, Vinton, Roanoke County.
Virginia Lithia Springs, near Manchester, Chesterfield County.
Virginia Magnesian Alkaline Spring, near Staunton, Augusta County.
Wallawhatoola Springs, Millboro, Bath County.
White Oak Mineral Spring, Norfolk, Norfolk County.
Wyrick Mineral Spring, Crockett, Wythe County.

WASHINGTON.

The returns from Washington indicate that sales were of about the same volume in 1909 as in 1908, the figures reported being 39,260 gallons and 38,900 gallons for the two years, respectively. The average selling price reported in 1909 was 6 cents higher than the price in 1908, being 41 cents. Two new springs, the Coulong and the Waters of Life, made the total number reporting 7. The water is used principally for the table, and there are no resorts at the springs, though the water at 2 is used for bathing. The 7 reporting springs are as follows:

Coulong Spring, Chelan County.
Diamond Mineral Spring, Auburn, King County.
Medical Lake Spring, Medical Lake, Spokane County.
Olympia Hygeian Spring, Tumwater, Thurston County.
Soda Spring, Yakima County.
Table Rock Spring, near Moffett Springs, Skamania County.
Wild Pigeon Spring, Cowlitz County.

WEST VIRGINIA.

Reports from West Virginia show some remarkable differences in output between the years 1908 and 1909. On the face of the returns the total volume of sales rose from 130,295 gallons in 1908 to 233,349 gallons in 1909, a gain of 103,054 gallons, or 79.09 per cent. The average selling price was 28 cents in 1909 compared with 50 cents for 1908. Three new springs made returns for the first time, the Red Cliff, the Saline Chalybeate, and the Walnut Hill, the total number reporting being 13. More than half of the water sold is used medicinally. There are resorts at 7 of the springs, accommodating over 2,500 people, and the water at 5 is said to be used for bathing. The following 13 springs reported sales:

Alum Springs, near White Sulphur Springs, Greenbrier County.
Bargers Springs, Bargers Springs, Summers County.
Barilithic Spring, Webster Springs, Webster County.
Borland Mineral Springs, Borland, Wood County.
Carney Sulphur Spring, Valley Heights, Summers County.
Greenbrier White Sulphur Spring, White Sulphur Springs, Greenbrier County.
Green Sulphur Spring, Green Sulphur Springs, Summers County.
Man-A-Cea Irondale Spring, Independence, Preston County.
Pence Spring, Pence Springs, Summers County.
Red Cliff Spring, near Wheeling, Ohio County.
Saline-Chalybeate and Vigoro Spring, Woodside, Ohio County.
Walnut Hill Spring, Charleston, Kanawha County.
Webster Springs, Webster Springs, Webster County.

WISCONSIN.

Although sales of mineral water in Wisconsin were only a little larger in 1908 than in 1909, according to the returns, the State held first place in value of water sold. The total sales were given as 6,101,882 gallons. The value decreased considerably, from $1,239,907 in 1908 to $1,132,239 in 1909, a loss of $107,668, or 8.68 per cent, although the average selling price per gallon in spite of a different basis of valuation, decreased only 1 cent. The statistics for the last six years have been as follows:

Production and value of mineral waters in Wisconsin, 1904–1909.

Year.	Springs reporting sales.	Quantity sold (gallons).	Value.	Year.	Springs reporting sales.	Quantity sold (gallons).	Value.
1904	25	6,586,834	$1,546,535	1907	29	6,839,219	$1,526,703
1905	27	6,656,834	1,454,715	1908	28	6,084,571	1,239,907
1906	27	7,702,718	2,397,694	1909	34	6,101,882	1,132,239

Seven new springs reported sales, as follows: Bryant Silver, Horeb Crystal, Kusche, Maskanozes, Minniska, Sheridan Mineral, and West Side, increasing the total number reporting to 34. Only a little over 10 per cent of the total water sold is used medicinally. There are resorts at only 4 of the springs, with accommodations for nearly 2,000 people, and the water at 2 is said to be used for bathing. In addition to the sales it is stated that there were sold 1,225,077 gallons used in the manufacture of soft drinks.

The reporting springs are as follows:

Allouez Spring, Green Bay, Brown County.
Alta Spring, Dunfield, Lincoln County.
Bay City Spring, Ashland, Ashland County.
Bethania Spring, Osceola, Polk County.
Bryant Silver Spring, Madison, Dane County.
Chippewa Spring, Chippewa Falls, Chippewa County.
Darlington Mineral Spring, Darlington, Lafayette County.
Elim Mineral Spring, Wannatosa, Milwaukee County.
Kusche Spring, Oshkosh, Winnebago County.
Lebenswasser Spring, Green Bay, Brown County.
Maribel Mineral Spring, Maribel, Manitowoc County.
Maskanozes Spring, Butternut, Ashland County.
Nee-Ska-Ra Spring, Wauwatosa, Milwaukee County.
Rainbow Spring, Wautoma, Waushara County.
St. John Mineral Spring, Green Bay, Brown County.
Salvator Spring, Green Bay, Brown County.
Sanitas Fountain Spring, near Oshkosh, Winnebago County.
Sheboygan Mineral Spring, Sheboygan, Sheboygan County.
Sheridan Mineral Springs, near Lake Geneva, Walworth County.
Solon Springs, Solon Springs, Douglas County.
Waukesha Springs, Waukesha County:
- Almanaris Spring.
- Anderson's Spring.
- Arcadian Spring.
- Bethesda Spring.
- Clysmic Spring.
- Crystal Rock Spring.
- Fox Head Spring.
- Glenn Rock Spring.
- Horeb Crystal Spring.
- Minniska Spring.
- Roxo Spring.
- Silurian Spring.
- White Rock Spring.

West Side Spring, Reedsburg, Sauk County.

WYOMING.

The DeMaris spring reported for the first time in 1909 and the State output increased accordingly. There are now 2 springs reporting. The water of one is used solely for the table, and that of the other medicinally. There are resorts with bathing facilities at both springs, and the water of both springs is used for the manufacture of soft drinks. These springs are:

DeMaris Spring, Cody, Bighorn County.
Saratoga Hot Springs, Saratoga, Carbon County.

MONAZITE AND ZIRCON.

By Douglas B. Sterrett.

INTRODUCTION.

There is a constant demand for minerals carrying thorium for the manufacture of incandescent gas mantles. A large number of such minerals are known to the mineralogist, though only one, monazite, has been found in quantities large enough to supply the commercial demand. Two other minerals that carry a large percentage of thoria—thorite and thorianite—have been obtained in small quantities from Ceylon.

Monazite is a phosphate of cerium, lanthanum, praseodidymium, and neodidymium containing a variable percentage of silica and thoria. Its content of thoria ranges from less than 1 per cent to more than 20 per cent. The quantity in monazite used for commercial purposes ranges from 3 to 9 per cent. In color monazite ranges from grayish to yellow, reddish, brownish, or greenish. Its luster is resinous and is especially brilliant on cleavage faces. It is opaque to translucent or subtransparent. Its specific gravity ranges from 4.9 to 5.3 and is generally over 5, so that it is readily concentrated by ordinary methods of washing. It is brittle, having a hardness of 5 to 5.5. Monazite generally occurs in small crystals with brilliant faces in the original rock matrix. When set free from the rocks and deposited in gravel beds by streams these crystals are rounded by attrition.

The world's sources of supply of monazite for many years have been Brazil and the United States. The Brazilian output is shipped to Germany, Austria, and England for manufacture into thorium salts. The greater part of the monazite produced in the United States is used in this country, though small quantities are exported annually. For a number of years past the supply has come from North Carolina and South Carolina, but it is probable that Idaho will add materially to the production hereafter. Deposits of monazite exist in other Western States and in Georgia and Virginia.

Practically all the monazite of commerce is derived from placer or gravel deposits. Unsuccessful attempts have been made to extract it from its original rock matrix on a commercial scale in North Carolina. Monazite placer deposits are worked like gold placer deposits, by sluicing and hydraulicking, and the crude sand obtained is further cleaned on concentrating tables or by electro-magnetic machinery. In the United States the final cleaning of monazite before shipment is accomplished by three different types of electro-magnetic cleaning machines. These are specially adopted forms (1) of the Wetherill, in use by the German American Monazite Company, (2) a machine devised by the Carolinas Monazite Company, and (3) a new type made and patented for the Centerville (Idaho) Mining and Milling Company. These machines can be adjusted to clean the sand to 95 per cent monazite, though the shipping grade is not generally so carefully cleaned.

MONAZITE IN IDAHO.

The occurrence of monazite in Boise County, Idaho, has been known for a number of years, and was first described by Waldemar Lindgren[a] in 1896. The investigations made by the Geological Survey at Portland in 1905 of the black sands of the Pacific slope demonstrated that monazite[b] occurred in ten counties of Idaho. A description of the occurrence of monazite in Nez Perce County has lately been given by F. C. Schrader.[c] Mention has been made of monazite in Idaho in several of the annual reports on the Mineral Resources of the United States by the Geological Survey. Information for the following description of the Centerville mines was obtained during a brief visit by the writer early in June, 1910.

The country rock in all portions of the monazite deposits examined near Centerville is granite. Between Centerville and Idaho City, 7 miles southeast, the region is composed of the same type of rock. This granite is a medium-grained gray variety, with a porphyritic texture in places. Constituent minerals are white feldspar, probably of the potash variety, with some plagioclase, glassy gray quartz, biotite, and muscovite. Seams and streaks of muscovite mica, with a pegmatitic development of the quartz and feldspar for a width of an inch or two on each side, are not uncommon in the granite. Quartz veins, inclining to pegmatitic nature, also occur in the granite masses.

The placers contain bowlders, cobbles, and gravel of granite, granite porphyry, quartz porphyry, monzonite and other porphyries, and quartz. The quartz porphyry cobbles are hard and more resistant than those of granite. They are also more rounded and waterworn than the granite, showing longer transportation. Many of the granite bowlders are friable and crumble to pieces rather easily.

The granite of the Centerville region is a portion of the same immense area described by Lindgren[d] as embracing the whole upper drainage of Boise and Payette rivers, extending northeastward beyond the Sawtooth Mountains and eastward as far as Wood River. It is probable that this area of granite is part of the same large batholith of granite extending for 300 miles north and south through central Idaho, with which other deposits of monazite occur.[e] Lindgren mentions the presence of dikes of porphyritic rocks in the Boise Basin, and it is doubtless such dikes that have supplied this type of rock found in the placers.

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[a] Eighteenth Ann. Rept. U. S. Geol. Survey, pt. 3, 1898, pp. 677-679.
[b] Day, D. T., and Richards, R. H., Mineral Resources U. S. for 1905, U. S. Geol. Survey, 1906, pp. 1194-1201.
[c] Monazite in northern Idaho: Bull. U. S. Geol. Survey No. 430, 1910.
[d] Lindgren, Waldemar, Mining districts of Idaho Basin and Boise Ridge, Idaho: Eighteenth Ann. Rept. U. S. Geol. Survey, pt. 3, 1898, pp. 630-632.
[e] Schrader, F. C., Monazite in northern Idaho: Bull. U. S. Geol. Survey No. 430, 1910.

The granite of the Centerville region has undergone considerable surficial disintegration, so that outcrops of hard fresh rock are not abundant. Many of the outcrops are composed of rounded bowlders of friable granite, with sharp angular granite soil accumulated around them. Large areas are covered with this same granite soil, with but little unaltered rock left. This soil is loose and washes down easily to the valleys, where it forms a considerable portion of the tailings and placer deposits.

Since the gravels of the placers are composed chiefly of rocks to be found in the immediate region, it is reasonable to suppose the monazite and the associated black sands were derived from the same source. This supposition is supported by tests made on the granite soil. Some of the loose, sandy granitic soil from a hill slope was found to carry an appreciable quantity of monazite when panned. Another sample taken from the apex of a small hill consisting of decomposed granite in place also yielded a few grains of monazite on panning. A small number of very fine zircon crystals were present in these concentrates also. The loose wash soil, still evidently only decayed granite, found in the hollows and not part of the regular placers, also carries monazite.

The heavier minerals commonly found in the monazite concentrates in the Centerville region are monazite, titanic iron, garnet, and zircon. Other allied minerals may be present, but have not been identified in quantity.

The first thorough test and mining for monazite in Idaho has been undertaken by the Centerville Mining and Milling Company. This company owns about 6,000 acres of land along Grimes Creek and Quartz Creek and their tributaries in the Centerville region. Large areas of gravel beds and terraces have been worked for gold in the past along the creeks. During the washing for gold the monazite content of the gravels was not removed but underwent a partial concentration along with small amounts of gold lost during mining. The tailings from the early washings have been spread over large areas of bottom land and to considerable depth in places, furnishing immense quantities of gravel to be washed for monazite and also yielding a little gold. These tailings have been washed out over considerable areas of virgin gravels in the valleys below creek level. The latter gravels were not available for washing with the simpler methods used in the early days of mining, but can now be worked by improved methods. The beds of virgin gravel are from a few feet to 20 feet thick. Where the bottom-land gravels extended back up tributary valleys or terrace gravels were found along the sides of the valley in favorable places they were washed for gold on a large scale. The tailings from these washings were turned over the bottom-land gravels, which they have covered to depths in places of over 30 feet. These beds of tailings vary from 100 to over 600 yards in width and extend several miles up and down Grimes and Quartz creeks.

The company has treated only so much gravel and tailings for monazite as was necessary to work out a method of treatment of both types of deposits and to save both the gold and the monazite. No sand has yet been sold. Virgin gravels have been worked for gold alone in different parts of the property in order to help defray expenses during the construction and experiments of the monazite cleaning mill. This work is said to result profitably, and the tailings are allowed to accumulate for later treatment. There is an abundant supply of pine timber on the surrounding mountains, and the company owns its own sawmill for supplying the requirements of the mine.

Through the courtesy of Mr. S. K. Atkinson, engineer and manager, the writer was given the privilege of examining the deposits and the methods used in mining and cleaning monazite. At the time of visit ordinary hydraulic mining methods were being used on the gravel beds above the creek level and hydraulic mining with hydraulic elevators on the gravels below the creek level. The company has ordered a pneumatic pipe dredge to work the latter type of deposit.

Special methods of treating the gravels for monazite have been devised. The gold is first caught in riffles with quicksilver in the sluices from the hydraulic mining. The riffles are cleaned up at the end of the season or at shorter intervals.

The tailings from placer and hydraulic mining are sent to the mill in a flume. They are discharged from the bottom of the latter through a grizzly 12 feet long and 4 feet wide, with wedge-shaped bars one-eighth inch apart, into a chute leading to a sump in the lowest part of the mill. From the sump the sand is carried by bucket conveyor to 3 revolving sizing screens of 3, 4, and 6 mesh. The material under 6 mesh from the last screen is carried by bucket conveyor 50 feet higher to storage bins in the upper part of the mill. From the bins the wet sand is automatically fed into vats with pipes leading to concentrating tables. At the time of visit concentration was accomplished by a battery of 2 Wilfley tables and 4 Card tables. The capacity of the plant is now being increased to 12 tables, to be arranged as follows: A battery of 6 Wilfley tables below and a battery of 2 Wilfley tables and 4 Card tables directly above. Under present conditions the sand comes from the tables as first, second, and sometimes third grades with tailings. The first grade generally runs over 40 per cent monazite, the second grade contains about 25 per cent, and the third grade 10 to 15 per cent. The second and third grades are run over a Pinder table, either separately or together, and raised to a higher grade. With the new arrangement of 12 tables the second and third grades from the 4 Card tables will be run over a Wilfley table below, and the second grade from all the Wilfleys over the Pinder table.

The cleaned sand from the concentrating tables is dried in a revolving inclined cylinder by a wood fire. The dried sand is fed by a chute to a bucket conveyor and carried to a bin above the magnetic concentrators. The sand is sized, and all below 20 mesh is fed to a Lovett magnetic separator, which removes the magnetic iron. The titanic iron and garnet are removed next by one of the new types of electro-magnetic cleaning machines designed by Herman W. Freese for the company. The monazite is next removed in 5 machines of the same type with the latest improvements applied.

For the operation of the hydraulics and placers, Mr. Atkinson states, it was necessary to repair about 60 miles of ditches and construct one new ditch 9 miles long. This ditch has a tunnel 350 feet long under one hill and numerous bridges over small valleys. The volume of water available for mining is estimated at 5,000 miners' inches in the wet season and about half that quantity in the dry season. Water is used under varying pressure up to a head of 200 or 300 feet, and greater pressure can be obtained. The quantity of gravel that can be treated for gold and monazite is limited by the capacity of the mill. It is estimated that over 1,000 tons of tailings can be run through the mill and the monazite removed in twenty-four hours. In two tests, made on a 100-pound sample and a cubic-foot sample weighing 105 pounds, it was found that approximately one-third of the gravel is over 6 mesh and would therefore not be sent over the concentrating tables. That is, 1,500 tons of gravel can be mined and treated for gold and monazite per twenty-four hours. With 1 cubic foot of gravel weighing 105 pounds the capacity of the plant, 1,500 tons, is approximately 1,058 cubic yards of gravel washed through the flume per twenty-four hours.

With the exception of the Lovett machine the electro-magnetic cleaning machinery in use by the Centerville Mining and Milling Company was devised and is being patented by Herman W. Freese, of the allied company, the Black Sand and Gold Recovery Company, of Chicago. Cleaning is accomplished by means of electro-magnets arranged around the circumference of a cylinder revolving over a conveying belt. The magnets are excited by an electric current when near the conveying belt, and the current is automatically cut off when they are in the proper position to discharge the sand attracted to them. The capacity of the 5 machines removing monazite is from 2,000 to 2,500 pounds of cleaned sand per day of ten hours. The Lovett machine for removing magnetic iron and the Freese machine used to remove titanic iron and garnet have a capacity sufficient to feed these 5 cleaners. Power for operating the mill is obtained from a high potential electric power line with a generating plant on the Payette River some 12 miles distant.

Although careful records have not been kept of the per cent of monazite recovered from the gravels washed, Mr. Atkinson estimates that practically all the tailings and gravels will yield at least 0.1 per cent; the tailings from some of the old workings are known to be very much richer. The results of two tests of tailings overlying virgin gravels along Grimes Creek, made at the time of the writer's visit, are given below. Both samples were air dried. No. 2 represents 1 cubic foot of gravel. Only material under 6 mesh was cleaned electromagnetically.

Tests of monazite tailings from Grimes Creek gravels, Idaho.

	1.	2.
	Pounds.	*Pounds.*
Weight of sample	100	105
Under 6 mesh	68	71.5
Over size	32	33.5
	Ounces.	*Ounces.*
Magnetite, Titanic iron, Garnet	4.75	4.6
Monazite	2.5	2.51
Quartz, zircon, etc	4.5	5

The results of these tests give 0.156 per cent and 0.149 per cent for 1 and 2, respectively, of monazite in the gravels. Pannings from selected portions of the tailings, probably near old sluices where clean-ups for gold were made will run considerably over 1 per cent monazite. If the gravels should yield an average of 0.15 per cent of monazite and 1,500 tons of gravel were washed per twenty-four hours, the output would be 4,500 pounds. At this rate the magnetic machinery would have to be run about twenty hours per day. The sand from the Freese cleaners averages nearly 95 per cent monazite, a very good grade for shipping.

The average thoria content as determined by numerous analyses, made both by the company's assayer and by commercial assayers, is stated to be 5.2 per cent for 100 per cent pure sand. This would give 4.94 per cent thoria in shipping sand cleaned to 95 per cent monazite. Analyses were made by Dr. R. C. Wells, of the United States Geological Survey, of monazite from Centerville cleaned to about 95 per cent by the Freese electromagnetic cleaner. This material represented the shipping grade of the monazite of the Centervilie Mining and Milling Company. The following notes on the methods employed have been prepared by Doctor Wells to accompany the results of his analyses:

In the chemical examination of monazite sands which have come to the Survey from time to time, various analytical processes have been tried out and the essential precautions for accuracy determined. It is difficult to get a complete decomposition of the minerals in a monazite sand by any single operation, and although an attack by sulphuric acid or an acid flux is the course recommended by most authorities the end is secured about as quickly by first fusing with sodium carbonate and extracting the phosphate with water; this is particularly desirable if phosphorus is to be determined.

Usually three or four attacks of the residue, by both acid and alkali fluxes, are required to get all of the rare earths into solution. All the thorium is precipitated by an excess of oxalic acid even in the presence of ammonium salts.

The oxalates may be converted into nitrates by warming with fuming nitric acid or into chlorides by boiling with caustic soda, filtering, washing the hydroxides, and dissolving in hydrochloric acid.

A number of methods for determining the percentage of thoria in monazite sand have been proposed. One of the quickest is that of Benz,[a] which depends upon the precipitation of thorium peroxide by hydrogen peroxide. The older procedure, in which the thorium is separated by boiling with sodium thiosulphate, is probably more reliable but demands a little longer time to carry out.

In the peroxide method it is essential to have the nitrate solution absolutely neutral. Test experiments showed that even under these conditions there is a strong likelihood that thorium will not be completely precipitated by hydrogen peroxide. Moreover, in the presence of cerium several reprecipitations are required to get rid of the cerium, and it is practically impossible to get rid of it completely. Hence the peroxide method rests partly upon a compensation of errors. Results obtained by it are a fair approximation of the truth.

With the thiosulphate method also it usually requires more than one precipitation to get a product free from cerium, and it is best to convert the last precipitate first into hydroxide then into oxalate again in order to get it wholly free from impurity.

For the lack of time not all of the possible precautions were employed in the determinations below, which were made on monazite from the Centerville Company. The results therefore show the variations likely to arise by modified procedures.

Determinations of thoria in monazite sand from Centerville Company, Idaho.

[R. C. Wells, analyst.]

	Per cent ThO_2.
1. Alkali attack, one reprecipitation of peroxide	2.64
2. Acid attack, one reprecipitation of peroxide	3.34
3. Attack with sulphuric acid and one precipitation with sodium thiosulphate	3.22
4. Alkali attack, one precipitation with thiosulphate	3.06
5. Varied attack, two precipitations with thiosulphate	2.77
Mean	3.01

[a] Zeitschr. angew. Chemie, 1902, p. 307.

A good review of the methods of separating thorium from the other earths has been given by Metzger.[a] A. C. Neish used m-nitro benzoic acid, which, however, precipitates erbium with thorium and zirconium if present.[b] W. B. Giles recommends the use of freshly prepared lead carbonate.[c] J. C. H. Mingaye has published experiments showing a comparison of these and the older methods of determining thorium.[d]

Analyses were made in 1906 by W. F. Hillebrand of monazite from the Centerville region. Unfortunately it is not known to what extent the sand was cleaned and the analyses were all made on the same sample, each analysis being of material removed by electric currents of different strength in an old type of Wetherill electro-magnetic cleaning machine. The results are given in the following table:

Determinations of thoria in monazite sand from Centerville region, Idaho, made in 1906.

[W. F. Hillebrand, analyst.]

					Over 4.	
					Light.	Heavy.
Amperes of current used	2.25	2.75	3.00	3.50		
Per cent thoria	4.47	3.48	2.60	2.41(?)	4.42	4.60

Of the material removed by the magnets with a current of over 4 amperes there appeared to be two grades separable by panning. Analyses were made of each of these. Since records were not kept of the relative quantities of monazite removed with the currents of different strength, it was not possible to obtain the average thoria content of the sample.

MONAZITE IN AUSTRALIA.

Attention was called to the occurrence of monazite in the sands of the Richmond River, New South Wales, in 1903, by J. C. H. Mingaye.[e] Since that time monazite has been found at several other localities in Australia. To determine the value of some of these sands Doctor Mingaye[f] made a determination of the content of thoria in monazite obtained from two localities. To select the best method of analysis a series of analyses were first made on monazite from North Carolina by different chemical methods. Doctor Mingaye found 3.90 per cent of thoria in monazite from the Wolfram field, near Cairns, northern Queensland, and 4.11 per cent of thoria in monazite from Black Swamp, Torrington, New South Wales.

PRODUCTION.

The statistics of the production of monazite in the United States in 1909 have been collected cooperatively by the Bureau of the Census and the United States Geological Survey. The production of crude monazite sand amounted to 1,976,329 pounds, averaging about 25 per cent monazite. The crude concentrates yielded 541,931 pounds of refined sand, whose value before cleaning was $65,032, or 12 cents per pound. Of this production, 391,068 pounds, valued at $46,928, came from North Carolina, and 150,863 pounds, valued at $18,104, from South Carolina. The value of 12 cents per pound

[a] Jour. Am. Chem. Soc., vol. 24, 1902, pp. 275, 901.
[b] Jour. Am. Chem. Soc., vol. 26, 1904, p. 783.
[c] Chem. News, vol. 92, 1905, pp. 1–3, 30.
[d] Rec. Geol. Survey New South Wales, vol. 8, 1909, pp. 276–292.
[e] Rec. Geol. Survey, New South Wales, vol. 7, pt. 3, 1903, p. 222.
[f] Rec. Geol. Survey, New South Wales, vol. 7, pt. 4, 1904, pp. 276–283.

placed on the monazite is the rate paid the miners per pound of refined sand obtained by electro-magnetically cleaning their crude concentrates. It does not represent the value of the refined material, but of the quantity of crude concentrates necessary to yield 1 pound of refined monazite. The cost of cleaning is not included. The average price of crude monazite concentrates was 3⅓ cents per pound.

The following table gives the production and value of monazite from 1893 to 1902, inclusive; of monazite and zircon in 1903; of monazite, zircon, gadolinite, and columbite in 1904; of monazite, zircon, and columbite in 1905; of monazite and zircon in 1906 and 1907; and of monazite in 1908 and 1909:

Production, in pounds, of monazite in the United States, 1893–1909.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
1893	130,000	$7,600	1902	802,000	$64,160
1894	546,855	36,193	1903	[a] 865,000	65,200
1895	1,573,000	137,150	1904	[b] 745,999	85,038
1896	30,000	1,500	1905	[c] 1,352,418	163,908
1897	44,000	1,980	1906	[d] 847,275	152,560
1898	250,776	13,542	1907	[e] 548,152	65,800
1899	350,000	20,000	1908	422,646	50,718
1900	908,000	48,805	1909	541,931	65,032
1901	748,736	59,262			

[a] Including 3,000 pounds of zircon, valued at $570.
[b] Including the small production of zircon, gadolinite, and columbite.
[c] Including a small quantity of zircon and columbite.
[d] Including 1,100 pounds of zircon, valued at $248.
[e] Including 204 pounds of zircon, valued at $46.

The production of monazite in the United States in 1909 was, as usual, confined to North Carolina and South Carolina. Some mining and cleaning of monazite was done at Centerville, Idaho, but none of the sand was placed on the market. The company operating in this region is holding its output with the expectation that monazite will have an increased value through the discovery of some use for its other constituents than thoria. An extensive series of tests are being made with this in view.

The production of refined monazite in the United States in 1909 was greater by 119,285 pounds in quantity and $14,314 in value than in 1908. This increase was due to larger outputs in both North Carolina and South Carolina. The production was less by 6,017 in quantity and $722 in value than in 1907 and was considerably smaller than in 1906.

IMPORTS AND EXPORTS.

According to the Bureau of Statistics of the Department of Commerce and Labor, there were 69,988 pounds of monazite and thorite, valued at $8,324, and 17,549 pounds of thorium oxide and other salts, not nitrate, valued at $19,596, imported into the United States during 1909. The imports of thorium nitrate were large, and are given, along with those of the preceding six years, in the following table:

Imports, in pounds, of thorium nitrate into United States, 1904–1909.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
1903	64,520	$232,155	1907	51,441	$152,666
1904	58,655	249,904	1908	65,289	173,239
1905	52,378	269,504	1909	127,833	236,057
1906	40,090	139,929			

The imports of thorium nitrate for 1909 were but little less than twice as great as the imports for any one of the six preceding years. The price per pound in foreign markets as deduced from this table was only $1.85, as against $2.65 in 1908 and $2.97 in 1907. If the imports of oxide of thorium and other thorium salts, not nitrate, are added to that of the nitrate, it will be seen that the quantity of manufactured thorium salts imported in 1909 was considerably over twice as great as in any previous year. According to the London Times,[a] the price of thorium nitrate was dropped from $2.81 per pound to $2.37 and then to $1.72 by the Austrian Welsbach Company. This was done in retaliation for the breaking of a certain unwritten agreement between the Welsbach Company and the German Thorium Convention. It is said with the method of extraction used by the Thorium Convention thorium nitrate costs about $1.94 per pound, while the Austrian method is less expensive. With a 3 per cent discount on the $1.72 rate, making $1.67 per pound, the Welsbach Company disposed of some 145,464 pounds of thorium nitrate in a few days. The Thorium Convention was greatly embarrassed, since the contracts with its customers called for the advantage of low market rates. The Convention placed its price at $2.05 per pound. It is not known whether a new understanding will be reached and the price become settled again.

The reduction of the duty on monazite imported into the United States, under the terms of the new tariff revision, from 6 to 4 cents per pound, including thorite under the same rating, has opened a small market, at least for foreign monazite and thorite.

No exports of monazite were recorded by the Bureau of Statistics, though the output of one of the companies operating in the Carolinas is shipped to Germany.

ZIRCON.

There was a production of about 2,000 pounds of zircon, valued at $250, from the Jones mine, near Zirconia, N. C., operated by Messrs. M. C. and C. F. Toms. Of the output of zircon at the mine of C. H. Hackney, of La Harpe, Kans., in the Wichita Mountains, obtained during prospecting, none was placed on the market.

[a] Mines and Minerals, July, 1910, p. 768.

QUARTZ AND FELDSPAR.

By Edson S. Bastin.

QUARTZ.

INTRODUCTION.

The character, methods of grinding, and uses of quartz were described in the report on the production of quartz in 1908 [a] and need not be repeated here. This chapter, like the corresponding chapters published in previous years, deals only with massive crystalline quartz (often called vein quartz), with flint, and with quartzite used for other than building or paving purposes.

The gem varieties of quartz are discussed in the chapter on precious stones. Sandstone and quartzite used for building and paving, sand used for building and molding and in glass and pottery manufacture, and tripoli are also discussed in other parts of this volume.

PRODUCTION.

The output of quartz in the United States in 1909 (135,469 short tons) was nearly three times as large as that for 1908 (47,316 short tons) and more than four times that for 1907 (33,192 short tons). These great differences are due principally to the large amounts of quartz quarried in Arizona and Tennessee for use in copper smelting. As this material is sold crude at a very much lower price than quartz used for pottery, wood filler, etc., there was not a proportionate increase in the total value of the product in 1909 as compared with previous years. Specific reports in regard to market conditions were not obtained for 1909, but the figures indicate a notable increase in production in 1909 of quartz used in copper smelting and an increase in the amount of quartz used in pottery, wood filler, paints, etc. The prices for the better grades of quartz were the same as those for 1908 or were somewhat lower.

Most producers keep no record of the number of tons of their product used for various purposes and it has therefore been impracticable to obtain reliable figures for the production of abrasive quartz. Quartz used for abrasive purposes is therefore included in the figures tabulated below. It is estimated that in 1909 nearly 10,000 short tons were sold as an abrasive at an average price per short ton of a little over $1 for the crude and of nearly $10 for the ground product. No flint was produced in this country in 1909.

As heretofore, the figures record the quantity sold rather than the quantity mined.

[a] Quartz and feldspar: Mineral Resources U. S. for 1906, U. S. Geol. Survey, 1907, pp. 861-864.

Production of quartz in the United States in 1908-9, by States, in short tons.

State.	Crude.		Ground.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1908.						
Connecticut and New York	1,120	$2,000	11,427	$75,400	12,547	$77,400
Pennsylvania and Maryland	2,858	4,725	5,480	40,750	8,338	45,475
Other States [a]	22,500	30,594	3,931	36,688	26,431	67,282
Total	26,478	37,319	20,838	152,838	47,316	190,157
1909.						
Connecticut and New York	11,283	20,216	3,000	34,000	14,283	54,216
Pennsylvania and Maryland	5,288	10,764	8,300	61,100	13,588	71,864
Other States [b]	104,888	100,354	2,710	23,032	107,598	123,386
Total	121,459	131,334	14,010	118,132	135,469	249,466

[a] Includes Arizona, Colorado, Montana, Tennessee, and Wisconsin.
[b] Includes Arizona, Massachusetts, Michigan, Tennessee, and Wisconsin.

Production of quartz in the United States, 1905-1909, in short tons.

Year.	Crude.		Ground.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1905	[a] 39,555	$33,409	11,590	$70,700	51,145	$104,109
1906	[a] 41,314	37,632	25,383	205,380	66,697	243,012
1907	5,618	4,282	27,574	219,519	33,192	223,801
1908	26,478	37,319	20,838	152,838	47,316	190,157
1909	121,459	131,334	14,010	118,132	135,469	249,466

[a] Exclusive of abrasive quartz.

IMPORTS OF FLINT PEBBLES.

The imports of flint pebbles into the United States in 1909 were valued at $301,547 for the crude material, as against $219,754 in 1908 and $288,371 in 1907.

QUARTZ INDUSTRY BY STATES.

Arizona.—Quartz was produced in Arizona by two firms operating near Dewey, in Yavapai County, and near Bisbee. The quartz was sold crude for use in smelting copper ores.

Connecticut.—There were no new developments in the quartz industry of Connecticut during the year. The production was not greatly different from that in 1908. The quarries were described in detail in the report on the production of quartz and feldspar in 1907.[a]

Maryland.—The quantity of crystalline quartz produced in Maryland in 1909 was nearly twice that for 1908. This notable increase was due mainly to the resumption of operations at Glen Morris, Baltimore County, by the Glen Morris Supply Company, whose mill was destroyed by fire in 1907, and to the production of the newly organized Husband Flint Company, which has rebuilt the burned

[a] Mineral Resources U. S. for 1907, pt. 2, U. S. Geol. Survey, 1908, pp. 846-847.

mill on Deer Creek, near Belair, formerly operated by the Diamond Flint Company. A number of other operators reported an increased production over that in 1908. The Maryland Silicate Mills, of Finksburg, in Carroll County, were sold in bankruptcy in December, 1910.

Massachusetts.—Quartz was quarried in Massachusetts by the Berkshire Mineral Company, near Blandford, in Hampden County, and in small quantity by the Enos Adams Company, near Cheshire, in Berkshire County.

Michigan.—A plant for mining and grinding quartz was put in operation during the year at Ishpeming, Mich., by the Michigan Quartz Silica Company. The quartz carries a small amount of free gold, which is saved. The finer grades of quartz are obtained by water flotation.

New York.—Crystalline quartz was produced in New York at only one locality, the Kinkle quarry, at Bedford, Westchester County. The number of tons produced was only slightly in excess of that for 1908. The quarry was leased to the Bridgeport Wood Finishing Company, which grinds the product for use in paints and wood filler. The Bedford deposit has been described in detail in an earlier report by the writer. [a]

Pennsylvania.—Crystalline quartz is now quarried at only two localities in Pennsylvania. These were visited by the writer in 1909 and are briefly described below.

The mine of the Columbia Flint Company is in Adams County near the Cumberland County line, about 2 miles from Bendersville and 3 miles northwest of Bendersville station, which is on the Gettysburg branch of the Philadelphia and Reading Railway. The workings, which are not extensive, consist of three principal and a number of minor open pits on a gently sloping southern hillside. The main pits are each about 100 by 50 feet and from 15 to 20 feet in maximum depth. The mine is worked only in summer. The quartz is white and opaque and contains here and there small cavities coated with dark-brown to nearly black oxide of manganese. Pieces containing such cavities are usually discarded in the mining. The quartz contains stringers of greenish-gray to dark-green talcose schist. The wall rock is not exposed at or near any of the pits, but is presumably similar to the schist stringers. The workability of various parts of the deposit depends largely on the size and abundance of the schist stringers.

The mill is at Bendersville station. It includes four intermittent kilns in which the quartz is burned during one night. This burning fractures it somewhat and facilitates crushing in the chaser mill. From the chaser mill the material goes to pebble mills, of which there are five, for fine grinding, and is then hoisted to bins and drawn into bags for shipment. Nearly all is used in the manufacture of pottery.

A small quartz quarry, owned and operated by H. T. A. Rhodewalt, is located in Chester County at Cornog station on the Pennsylvania Railroad. The quartz here forms a single nearly vertical vein or dike trending about N. 65° E. and showing an average width of about

[a] Quartz (flint) and feldspar: Mineral Resources U. S. for 1906, U. S. Geol. Survey, 1907, pp. 1265–1268; also Bull. U. S. Geol. Survey No. 315, 1907, pp. 394–399.

25 feet. The westernmost exposures are at the quarry, but the vein is traceable as a low ridge for nearly a quarter of a mile east of the quarry, which is a single open pit about 100 feet wide, 200 feet long in a N. 60° E. direction, and about 35 feet in maximum depth.

The quartz is white and massive and reasonably free from impurities. It is shipped crude, principally to Philadelphia, for the manufacture of sandpaper.

Tennessee.—Quartz is quarried in Tennessee in Polk and Bradley counties for use in copper smelting.

Wisconsin.—The Wausau Quartz Company, in Wisconsin, whose mill was destroyed by fire in June, 1907, completed its new mill in August, 1908, and has since been a steady producer. In 1909 it ground the product of the Wausau Sandpaper Company, but that company is now milling its own product. The quantity produced in 1909 was slightly in excess of that for 1908.

FELDSPAR.

PRODUCTION.

Full information in regard to the character, origin, uses of feldspar, the methods of mining and milling, and detailed descriptions of most of the quarries in the United States are given in a report by the writer, published as Bulletin 420 of the United States Geological Survey. This bulletin may be obtained free by addressing the Director of the Geological Survey at Washington.

The report on production for 1909 has been necessarily delayed because the returns were collected through the Bureau of the Census, and some information usually obtained, such as reports of market conditions, is lacking for the year. The statistics obtained indicate that the demand for feldspar of pottery grade was slightly better than in 1908—the panic year—but the prices are still so low that most of the small producers who suspended work in 1908 have not yet been able to resume operations. Of the total production recorded under the heading of feldspar, 18,413 short tons of ground material, valued at $37,646, was crushed pegmatite (very coarse granite) used for poultry grit and as a coating for tarred surfaces in the manufacture of ready roofing. Such material is prepared by crushing the pegmatite just as it comes from the quarry, without preliminary sorting, and contains white and brown mica and other minerals which must be hand cobbed out of pegmatite used in pottery or enamel ware. Most of the pegmatite deposits worked for roofing and poultry grit contain no feldspar of pottery grade, but others contain a small proportion which can be utilized in pottery. There is no reason why the waste from many of the quarries now producing only feldspar of pottery grade should not be crushed, screened, and sold for poultry grit and for roofing material, especially if such quarries are located close to transportation lines.

As usual, the figures tabulated below represent the output sold during the year and not the output actually quarried.

Production of feldspar in 1908–9, by States, in short tons.[a]

State.	Crude.		Ground.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1908.						
Connecticut	7,775	$27,753	8,641	$59,456	16,416	$87,209
Maine	168	375	13,751	123,034	13,919	123,409
Maryland	6,217	21,076	3,517	30,774	9,734	51,850
New York	504	1,350	14,109	51,798	14,613	53,148
Pennsylvania	3,616	13,226	10,473	90,276	14,089	103,502
Virginia, Minnesota, and Wisconsin	560	2,000	1,143	7,435	1,703	9,435
Total	18,840	65,780	51,634	362,773	70,474	428,553
1909.						
Connecticut	9,633	28,522	4,011	14,491	13,644	43,013
Maine	225	540	17,912	165,491	18,137	166,031
Maryland	4,056	13,504	2,508	21,895	6,564	35,399
New York	2	10	11,601	33,091	11,603	33,101
Pennsylvaina	9,103	30,067	9,470	81,399	18,573	111,466
California, Massachusetts, and Virginia	8,018	12,778	0	0	8,018	12,778
Total	31,037	85,421	45,502	316,367	76,539	401,788

[a] Includes abrasive feldspar.

Production of feldspar, 1905–1909, in short tons.

Year.	Crude.		Ground.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1905	[a] 14,517	$57,976	20,902	$168,181	35,419	$226,157
1906	[a] 39,976	132,643	32,680	268,888	72,656	401,531
1907	31,080	101,816	60,719	457,128	91,799	558,944
1908	18,840	65,780	51,634	362,773	70,474	428,553
1909	31,037	85,421	45,502	316,367	76,539	401,788

[a] Exclusive of abrasive feldspar.

FELDSPAR INDUSTRY BY STATES.

California.—Reports have been received concerning development work at two localities in California during 1909. Los Angeles miners have been engaged in prospecting and development work on feldspar deposits south of Dehesa and along San Diego River above Lakeside, in San Diego County, but no sales have yet been reported. In San Francisco County about 200 short tons were quarried but were not sold. The town nearest to this deposit is Chualar, in Monterey County, on the Southern Pacific Railroad.

Connecticut.—Most of the Connecticut producers reported a slight increase in the number of tons quarried in 1909 as compared with 1908. A portion of the plant of the Consolidated Feldspar Company near Middletown was in operation during the year and a considerable quantity of crushed pegmatite was sold for poultry grit and roofing. The quarry, which is 2¼ miles northeast of South Glastonbury and was operated in 1908 by a soap manufacturing firm, was idle in 1909. The Chatham (Middlesex County) and Glastonbury (Hartford County) quarries of the Eureka Mining and Operating Company were idle in

1909, the company's output coming largely from the Gillette quarry. Two new quarries were opened by this company in Middlesex County, one in Middle Haddam, on Connecticut River, and the other on Walkley Hill, in Haddam.

Maine.—It is interesting to note that as early as 1837 Charles T. Jackson, State geologist of Maine, called attention to the value of the feldspar deposits of the State, although their commercial utilization did not begin until many years afterward. The following quotation is taken from his report.

> Brunswick is underlain entirely by gneiss, which is intersected by numerous and powerful veins of granite, containing large crystals of feldspar, suitable for the manufacture of porcelain. Some of the veins on the Androscoggin, near the bridge to Topsham, are 25 feet wide, and will afford sufficient feldspar for the supply of porcelain works. I have had some of the mineral wrought into mineral teeth, by a distinguished dentist in Boston, in order to see whether it would answer for this purpose, and he declares that it makes a most perfect porcelain, which is of a pure semitransparent appearance. Many interesting minerals have been found in Brunswick and Topsham, which have been described in the excellent "Treatise on mineralogy" published by Professor Cleaveland.[a]

Most of the operators reported an increase in the number of tons mined in 1909 as compared with 1908. A feature of interest was the discovery in the course of feldspar mining for the Maine Feldspar Company, in Poland, of pockets containing many gem tourmalines of unusual size. A small quantity of feldspar was saved at the tourmaline mine at Mount Mica, near Paris, Oxford County, but was not marketed during the year.

Maryland.—The notable decrease in production in Maryland in 1909 as compared with 1908 was due mainly to the reduced output of the larger producers. Most of the small producers continued idle, as in 1908.

Massachusetts.—A large output of feldspar was reported by the Berkshire Mineral Company from a quarry near Blandford, in Hampden County, Mass. From the low value reported for this material it is inferred that it was crushed pegmatite rather than pottery feldspar.

Minnesota.—The North Shore Abrasive Company, which quarried a lime-soda feldspar, for use in filter beds and as an abrasive, at Point Corundum, Lake County, Minn., is out of business. The Minnesota Mining and Manufacturing Company, quarrying similar material at Crystal Bay, Lake County, was idle during 1909.

New York.—The production in New York for 1909 was almost entirely crushed pegmatite for poultry grit, roofing, etc. A few tons of pottery feldspar were sold from P. H. Kinkle's Sons quarry, at Bedford, Westchester County, and from the quarry of the Crown Point Spar Company, near Crown Point. The Claspka Mining Company's property near Batchellerville, in Saratoga County, was sold to the Adirondack Spar Company, of Glens Falls, N. Y.

Pennsylvania.—The production in Pennsylvania for 1909 shows a notable increase over that for 1908, due mainly to the tonnage reported by a new poducer, Oscar T. Quarll, from a quarry near Avondale, in Chester County. During the year a quarry for pottery feldpsar was opened near Twin Oaks, a station on the Baltimore and Ohio Railroad, near Chester, by the Twin Oaks Feldspar Company.

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[a] First report on the geology of the State of Maine, 1837, pp. 80–81.

The venture was largely advertised and a few hundred tons of feldspar were marketed, but the property was sold in bankruptcy in September, 1909. The quarry of Moses B. Carpenter, near Toughkenamon, in Chester County, was leased to the Pennsylvania Feldspar Company. Most of the small operators in Pennsylvania were idle in 1909 as in 1908.

Vermont.—The Keystone Manufacturing Company (A. L. Stone) continued development work on the feldspar property about 2 miles northeast of Chester depot, Vt., and reported the construction of a mill at Chester depot, but made no sales in 1909.

Virginia.—The Dominion State Mines Corporation reported an important production from its quarry near Prospect, in Prince Edward County, Va.

TALC AND SOAPSTONE.

By J. S. Diller.

INTRODUCTION.

The most important features of the talc and soapstone industry for 1909 were the decided increase in production and the marked decline in value, a decline which has been attributed, with apparent reason, to overproduction. Although the production in 1909 was the highest reported annual production except that of 1907, the average price of all forms of talc in 1909 was the lowest since 1905. This condition is in large measure the consequence of the increased sale of talc in the crude form, the manufacturers themselves preparing it in the form best suited to their purpose.

MODE OF OCCURRENCE.

Talc occurs in connection with ancient crystalline rocks such as form the axis of the Appalachian Mountain system from Maine to Alabama. It is a secondary natural product derived from the alteration of either sedimentary or igneous rocks. In New York and North Carolina, where the talc is interstratified with comparatively large masses of limestone, the schist from which the talc is derived by alteration is certainly of sedimentary origin, but in other places where it occurs in more or less irregular masses and is not associated with limestone it is derived from pyroxenite or similar rocks of igneous origin.

VARIETIES AND CHARACTERISTICS.

Talc—a hydrous silicate of magnesia—is remarkable on account of its softness and soapy feel. When pure it is generally foliated, but the folia, though flexible, are not elastic like those of mica.

Talc commonly occurs in small veins, but when impure it may form large schistose masses of talc schist, or in massive form may constitute bodies of soapstone. Wherever found it occurs in highly altered rocks, so that its origin in many cases is difficult to determine. In the massive form, however, as soapstone, the rock is less regular, and its structure, composition, and relations to the surrounding rocks indicate that it is derived from the alteration of a basic igneous rock, either pyroxenite or peridotite.

Besides the regular talc and soapstone which occur in many parts of the Appalachian region, there is another closely allied mineral—a silicate of alumina—called pyrophyllite, which is mined near Glendon in North Carolina.

USES.

There is a wide range in the use of talc, and near the mine there is usually a mill for grinding it to powder or for sawing it into slabs to prepare it for the special purpose for which it is best adapted.

Talc in the form of powder is used principally in the manufacture of paper for building purposes, and of shade cloths, curtains, and other fabrics. It is largely used also in the manufacture of molded rubber goods and as foundry facing. An important use, based upon its power of absorption, is in bleaching cotton goods and in removing grease spots from silk or cloth. Its widest application is as a lubricant to lessen friction. For this purpose, as French chalk, it is put into gloves and shoes, and is blown into conduits to ease the introduction of electric wires and other conductors.

The fine grades are used in toilet powders and soaps, and in the solid form for lava-tip gas burners and electrical blanks, as well as for crayons and pencils for marking various substances. Other grades are used for polishing and finishing stoves, rice, glass, skins, and leather.

Patents have been taken out covering its use as a final coat of plaster for colored mortar on walls and ceilings, and for blackboards.

Soapstone has been used principally in manufacturing laundry tubs, but during the last few years the demand for it for that use has been less active on account of the employment of other materials for the same purpose.

On the other hand, the use of soapstone in laboratories, especially for chemical purposes, has increased. This is well illustrated in the government and other laboratories at Washington, D. C., where the stone known in commerce as "alberene" is used for hoods, flues, sinks, and table tops, especially for chemical purposes in the bureaus of Chemistry, Animal Industry, Plant Industry, Soils, and Agricultural Experimental Stations, as well as in the National Museum, the Bureau of Standards, and the Geophysical Laboratory. This use of soapstone depends chiefly on its power to withstand strong acids and high temperatures, but is based somewhat on the fact that soapstone is an electric insulator, a feature which also adapts it for use in electric switchboards. According to the statement of the president of a large electrical manufacturing company alberene soapstone is a better insulator than slate or marble, and, what is more important, is practically nonabsorbent.

PRODUCTION.

With the exception of a small output in California, the production of talc and soapstone in the United States is limited to a comparatively narrow belt of ancient crystalline rocks lying in the Appalachian Mountains from Vermont and New York to Georgia.

The largest production of talc in the United States was attained in 1907, with a total of 139,810 tons. In 1908 the output was 117,354 tons, a decrease of about 17 per cent. The data concerning the production in the United States in 1909 were obtained chiefly by the Bureau of the Census in cooperation with the United States Geological Survey. The total production in 1909 was 130,338 tons, an increase of 11 per cent in quantity as compared with 1908. The enlarged production was due chiefly to the twelvefold increase in the combined production of crude talc and soapstone in both Vermont and Pennsylvania, and the increase of 39 per cent in manufactured products chiefly in Virginia. The increased production was not uniformly distributed among the States. It was greatest in Pennsylvania, but large also in Vermont, Virginia, and Massachusetts, with smaller increases in North Carolina, New Jersey, and Rhode Island. In New York the production decreased 22,203 tons, that is, about 31 per cent from the production in 1908. New York is still by far the largest producer in the United States, yielding nearly as much as Virginia and Vermont combined. Maryland also showed a decided decrease. This variation among the States holds no definite relation to the talc and soapstone resources of the States mentioned, for in Virginia there are large masses of soapstone and in New York great bodies of talc to supply the demands of the future. It is, however, a matter of regret that for the best grade of talc used in our factories we must go to France and Italy.

The development of the talc industry in the United States since 1880 is shown in the following table:

Production of talc and soapstone in the United States, 1880–1909, in short tons.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
1880-1900	969,928	$11,224,652	1905	96,634	$1,082,062
1901	97,843	908,488	1906	120,644	1,431,556
1902	97,954	1,140,507	1907	139,810	1,531,047
1903	86,901	840,060	1908	117,354	1,401,222
1904	91,189	940,731	1909	130,338	[a] 1,221,959

The various forms in which talc and soapstone are marketed may be conveniently noted in four groups or classes, viz, rough or crude, sawed into slabs, manufactured articles, and ground. The table below shows the quantity produced in each class, the total value, and the average price per ton annually from 1906 to 1909, inclusive. Twenty-one per cent of the production in 1909 was sold crude, 2 per cent in slabs, 17 per cent in manufactured articles, and 60 per cent ground in the form of powder.

Production of talc and soapstone in the United States according to varieties, 1906–1909, in short tons.

Condition in which marketed.	1906.			1907.		
	Quantity.	Value.	Average price per ton.	Quantity.	Value.	Average price per ton.
Rough	15,211	$40,337	$2.65	25,538	$34,625	$1.36
Sawed into slabs	4,980	83,563	16.78	4,822	91,688	19.01
Manufactured articles [b]	23,575	631,342	26.78	23,484	648,475	27.61
Ground [c]	76,878	676,314	8.80	85,966	756,279	8.80
Total [d]	120,644	1,431,556	11.87	139,810	1,531,047	10.95
	1908.			1909.		
Rough	3,013	$7,819	$2.60	27,412	$79,499	$2.90
Sawed into slabs	3,406	71,048	20.86	2,893	54,009	18.67
Manufactured articles [b]	16,336	442,624	27.10	22,646	502,447	22.19
Ground [c]	94,599	879,731	9.20	77,387	586,004	7.57
Total [d]	117,354	1,401,222	11.94	130,338	1,221,959	9.38

[a] The production of a certain mine which was first reported by the mines schedule of the Census Office as crude was later reported on the manufactures schedule as ground with greatly increased value. To this change is due the differences between the first form and the present form of this report.
[b] Includes bath and laundry tubs; fire brick for stoves, heaters, etc.; hearthstones, mantels, sinks, griddles, slate pencils, gas tips, burner blanks, crayons, and numerous other articles for everyday use.
[c] For foundry facings, paper making, lubricators for dressing skins and leather, etc.
[d] Exclusive of the quantity used for pigment, which is included among mineral paints.

In the following table those of the producing States containing more than two mines are given in alphabetical order; the remaining States are given together under "Other States" to avoid disclosing the production of individual mines. New York holds first rank in the number of tons produced, but in value of output Virginia exceeds all other States and is greater than New York and Vermont combined. In New York the production is all ground and in Virginia it is chiefly in manufactured articles, which accounts for its greater value. In Vermont the larger part of the production is sold ground, but nearly half, including a small quantity of manufactured material, is sold crude. Like Vermont, Pennsylvania and Massachusetts greatly increased their production of crude in 1909.

Production of talc and soapstone, 1907–1909, by States, in short tons.

State.	1907.		1908.		1909.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Georgia	739	$11,473	(a)	(a)	(a)	(a)
Maryland	5,064	32,250	(a)	(a)	(a)	(a)
Massachusetts	(a)	(a)	(a)	(a)	9,057	$48,729
New Jersey and Pennsylvania	17,103	46,871	4,648	$29,118	13,900	61,967
New York	67,800	626,000	70,739	697,390	48,536	359,957
North Carolina	4,085	74,347	3,564	51,443	5,956	77,983
Vermont	16,200	82,500	10,755	99,743	23,626	120,329
Virginia	26,278	631,880	19,616	458,252	26,511	523,942
Other States[b]	2,541	25,726	8,032	65,276	2,752	29,052
Total	139,810	1,531,047	117,354	1,401,222	130,338	1,221,959

[a] Included in "Other States."
[b] California, Massachusetts, and Rhode Island, in 1907; Georgia, Maryland, Massachusetts, and Rhode Island, in 1908; California, Georgia, Maryland, and Rhode Island, in 1909.

Production of talc and soapstone in the United States, 1880–1909, in short tons.

Year.	New York.		All other States.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1880–1900	629,925	$5,933,501	340,003	$5,291,151	969,928	$11,224,652
1901	69,200	483,600	28,643	424,888	97,843	908,488
1902	71,100	615,350	26,854	525,157	97,954	1,140,507
1903	60,230	421,600	26,671	418,460	86,901	840,060
1904	64,005	507,400	27,184	433,331	91,189	940,731
1905	56,500	445,000	40,134	637,062	96,634	1,082,062
1906	61,672	557,200	58,972	874,356	120,644	1,431,556
1907	67,800	626,000	72,010	905,047	139,810	1,531,047
1908	70,739	697,390	46,615	703,832	117,354	1,401,222
1909	48,536	359,957	81,802	862,002	130,338	1,221,959
Total	1,199,707	10,646,998	748,888	11,075,286	1,948,595	21,722,284

IMPORTS.

The total imports of talc for consumption in 1909 were 4,417 short tons, a decrease of more than 40 per cent from the imports of 1908. There was also a decrease of nearly 3 per cent in the average price per ton of the imports in 1909. Only the better grades of talc are imported, which accounts for the higher average price per ton for foreign as compared with the domestic talc.

Talc imported into the United States, 1902–1909, in short tons.

Year.	Quantity.	Value.	Average price per ton.	Year.	Quantity.	Value.	Average price per ton.
1902	2,859	$35,366	$12.36	1906	5,643	$67,818	$12.02
1903	1,791	19,677	10.99	1907	10,060	126,391	12.56
1904	3,268	36,370	11.13	1908	7,429	97,096	13.07
1905	4,000	48,225	12.05	1909	4,417	56,287	12.74

TALC DEPOSITS, BY STATES.

GEORGIA.

Georgia has lately become a considerable producer of talc, with two mills in operation for part of the year at Chatsworth. One of these mills, a new mill of the Georgia Talc Company, began operations in July, and the other, the old mill of the Cohutta Company, was in operation more or less regularly throughout the year 1909.

Talc of good pencil grade is found in the slates a few miles east of Chatsworth, but in this part of the field none has yet been found in the Murphy limestone belt. Nearly half of the output is in the form of pencils or crayons. Some of the material procured by washing is of toilet-powder grade, and this is all the more interesting since that grade of material has been found in this country thus far only in talc associated with limestone.

NEW YORK.

All of the talc produced in New York is ground and used as powder.

The talc region in St. Lawrence County, a northeast-southwest belt situated a few miles east of Gouverneur, continues to be the most productive in the United States, and gives New York its preeminence in the talc industry.

The talc of that region is intimately associated in various quantities with light-colored schists composed more or less completely of tremolite or enstatite, from the alteration of which, according to Prof. C. H. Smyth, jr., the talc is produced. The schists are conformably interstratified with limestones in a mass of gneiss, which occupies the greater portion of the region. The limestone is of sedimentary origin, and the interbedded schists which grade into the limestone and have given rise to the talc may be attributed to the same source.

The only talc deposit which has yet been opened and worked is a belt about 7 miles in length, running approximately northeast and southwest from the vicinity of Edwards and Talcville to Sylvia Lake, a few miles southwest of Fowler.

Mining operations are most extensive along the railroad toward the northeast end of the belt, where the active mines of the International Pulp Company, including Nos. 3 and 2½, as well as the United States mine, are located. The largest portion of the output of the belt is obtained in that vicinity and is handled by the Hailsboro, Columbia, and Dodgeville mills, belonging to the same company.

The Uniform Fibrous Talc Company is preparing for operations on the Freeman farm, near the United States mine, about a mile southwest of Talcville. The mine has already been opened on the body of talc. The large mill, with concrete basement surmounted by steel frame and with corrugated iron sides and roof, is now in course of construction. It is most advantageously located near the mine to facilitate direct delivery by gravity. The electricity for running the mill and mine will be developed from a competent water-power plant about $1\frac{1}{2}$ miles distant on the west fork of the Oswegatchie River.

In the southwest end of the talc belt there are three mines, the Balmat, the Arnold, and the Ontario. The Balmat and the Arnold, having a large body of ore on hand ready for the mill, are operated more or less irregularly to keep up the supply, which is shipped to the mills of the International Pulp Company.

The Ontario mine, near Fullerville, has been closed temporarily, but preparations are being made to open it again as soon as the mill, which has been running continuously, exhausts the supply on hand and demands more ore.

The talc belt of St. Lawrence County has been traced northeast beyond Edwards and southwest beyond Sylvia Lake. No new developments in 1909 have been reported to the northeast, but to the southwest, in Lewis County, near Natural Bridge, a production of talc was reported, probably from fibrous hornblende schist like that associated with the talc east of Gouverneur.

NORTH CAROLINA.

Although North Carolina, as shown by the United States Geological Survey folios (Mount Mitchell, Roan Mountain, Cranberry, Asheville, Pisgah, Nantahala, and others), contains many masses of soapstone, most of them are among the mountains with no facilities for transportation, and for this reason there is no commercial production of soapstone in the State.

On the other hand, North Carolina has long been a large producer of talc, and in 1909 showed an output of 5,956 tons, which is an increase of 67 per cent as compared with 1908. The principal active mines in the State are the North Carolina Talc Company, at Hewitts, in Swain County; the Alba Mineral Company, near Kinsey, in Cherokee County; the American Talc Company and the Glendon Mining and Manufacturing Company, at Glendon, in Moore County.

The mine at Hewitts is the largest of its kind in the State, and has produced the best grade of commercial talc yet found in this country, but unfortunately the operation of the mine is limited by underground water. A detailed description of the occurrence of talc and soapstone in the vicinity of Hewitts is given by Mr. Keith in the Nantahala folio (No. 143), and a briefer account is given in this report for 1908.

The operations of the Alba Mineral Company have been interrupted by water, but the promising quality of the talc which, like that of Hewitts, occurs in connection with the Murphy limestone, encourages the company to increase the capacity of the mine equipment. In the mill the output of the mine is converted into crayons or ground as desired.

Pyrophyllite.—The material mined near Glendon, though it resembles talc, is really pyrophyllite, a hydrous silicate of alumina that has many of the properties of talc and may be used for the same purposes. Its occurrence has been fully described by Dr. J. H. Pratt,[a] in Economic Paper No. 3, of the North Carolina Geological Survey. Of the four mines formerly at work in that region, only one is now in operation.

VERMONT.

Vermont is a large producer of both ground talc and soapstone. In the former it ranks next to New York and in the latter next to Virginia, although in total production it is exceeded by both States. The output in 1909 was 23,626 tons, an increase of 12,871 tons, or 119 per cent as compared with 1908.

The talc belt runs throughout the entire State of Vermont, and mines are scattered along the belt, but only those most favorably located with reference to transportation can operate at the present time. During the year 1909 there were 8 producing mines—at Johnson, East Granville, Rochester, and Perkinsville, besides the Carlton, the Davis, and the Athens mines, all of them tributary to Chester.

At Johnson, in the northern portion of the State, the American Mineral Company has operated a small mine and mill near the railroad under what appear to be favorable conditions. Moretown is some distance from the railroad and had no production in 1909, but considerable activity is being renewed and machinery installed in that region by the Moretown Talc Company.

The Eastern Talc Company continues in vigorous operation at East Granville, where the mine and mill are most conveniently located for gravity and railroad transportation to secure economical production. Although a large part of the talc is ground at the mill, much of it is shipped unground.

The United States Talc Corporation, which has for some years actively mined and milled talc near Rochester, has reorganized as the Standard Talc Company, with J. C. Fowle as general manager. The mill is near the branch railroad from Bethel, but there is a long wagon haul from the mine to the mill. The much shorter, direct, down-grade distance from the mine suggests that a gravity tramway might be advantageously used. This company controls also the Greeley mine, which is on the branch railroad near Stockbridge, 7 miles south of Rochester, and has obtained ore from that source. The ore can be delivered from the Greeley mine by chute from mine to railroad and can readily be furnished to the Rochester mill.

With the new mill at Perkinsville, the mine there has continued production. A change to be noted at Chester is the active operation of Carlton's mine under lease by the American Soapstone Finish Company, with a factory for various finished products at Chester Depot. This company uses not only the material from the Carlton mine, but also the waste soapstone from the saws of the Union Soapstone Company. The mill of the Union Soapstone Company is at Chester Depot, and the soapstone used is said to be derived in part from the Davis quarry near Chester and in part from the quarry at Athens, 10 miles south of Chester. There has been active prospecting on Mr. King's farm, 8 miles west of Chester, and at many other points on the talc belt; but so far as known there has been production in 1909 only at the 8 mines mentioned.

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[a] Econ. Papers, No. 3, North Carolina Geol. Survey, 1900, 29 pp.

VIRGINIA.

Virginia holds first rank among the States in the production of soapstone, and in 1909 the production for the most part was confined to a narrow belt extending northeast and southwest, perhaps continuously, through Nelson and Albemarle counties and outcropping here and there farther northeast in Orange and Fairfax counties. A second productive belt of much less importance occurs in Amelia County, southwest of Richmond.

Within the principal belt in Nelson and Albemarle counties there were in 1909 six active mines, of which the Old Dominion was the most northeastern, followed in succession toward the southwest by the Schuyler, Climax, Eureka, Phœnix, and Piedmont.

Prof. T. L. Watson, state geologist of Virginia, in describing the mineral resources of Virginia, gives an account of the geology of this soapstone belt. The harder grades of soapstone contain a larger proportion of the hard minerals—hornblende and pyroxene—and a smaller proportion of talc than the softer grades. On this account the harder rocks are susceptible of a smoother, brighter finish, which renders them more attractive, although they do not take as high a polish as marble. Nearly all of the mines are now at work in new openings. In the case of the Old Dominion and the Schuyler the new openings are already producing, but at the Phœnix, to which the old machinery of the National has recently been removed, the new opening did not reach a producing depth in 1909.

In the Amelia County soapstone belt there has been more or less irregular production at Jetersville and at Lynch.

Considerable prospecting has been done in the northeastern extension of the Nelson-Albemarle soapstone near Reynolds, in Orange County, where the rocks are of essentially the same general character as in Albemarle. At Wiehle, in Fairfax County, there is a talc mine from which the crude material has been shipped for a number of years. The deposit is irregular, but widely distributed in association with chloritic and hornblendic schists.

An impressive feature at nearly all of the soapstone mines and mills, especially in Virginia, is the very large amount of waste rock. It is estimated by some of the engineers in charge, whose long experience has given them the best means of knowing the facts in the case, that the waste is 90 per cent of all the rock quarried. There seems to be a very small percentage of profitable production, but it includes only that material which is actually used in manufacturing articles. A very large part of the soapstone that is sawed into slabs is waste; some of this material, when sufficiently rich in talc, might be ground and utilized in the form of powder.

MARYLAND.

The only company operating in Maryland during 1909 was the Deland Mining and Milling Company, near Havre de Grace. It produced ground talc only, and the quantity reported in 1909 was little more than half that reported for 1908.

MASSACHUSETTS.

Four producing companies reported in Massachusetts—the Berkshire Talc Manufacturing Company, at Dalton, Berkshire County; the Massachusetts Talc Company, and the Foliated Talc Company, both in the town of Rowe, Franklin County; and the Northampton Talc Company, near Savoy, in Hampshire County. All produced ground talc. The Massachusetts Talc Company, which is by far the largest producer in the State, reported also a considerable quantity of crude, and a production more than double the output of 1908; its mill at Zoar, on the Fitchburg Railroad, though not the largest, is one of the best in the country. The ground talc is graded entirely by a pneumatic process, and the powder thus obtained is remarkable for its uniformity.

NEW JERSEY.

The Lizzie Clay and Pulp Company, 2 miles north of Phillipsburg, reported an increase of about 18 per cent in the output of the mine for 1909. The product is given as ground.

PENNSYLVANIA.

Three mines were active in Pennsylvania—two near Easton, operated by J. O. Wagener & Co. and C. K. Williams & Co., and the third in Montgomery County, owned by the Atlas Mineral and Machine Company. The output of the State in 1909 was about four times as large as that of 1908.

RHODE ISLAND.

The production of Rhode Island was small, there being but one mine, though the output increased 29 per cent over the output of 1908. The operating company was the Rhode Island Soapstone Company, and the mine, located at Manville, in Providence County, reported a production of both crude and ground talc.

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