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ILLUSTRATIONS.

COAL.

By Edward W. Parker.

INTRODUCTION.

GENERAL STATEMENT.

The first contribution on the production of coal prepared by the present writer for the volumes of Mineral Resources covered the two calendar years of 1889 and 1890. The statistics for 1889 had been collected by the Bureau of the Census and no separate report for that year was published by the United States Geological Survey. The statistics for 1890 were the first compiled by the writer, the former author of this series, Dr. Chas. A. Ashburner, of Pittsburgh, Pa., having died in 1890 while engaged on the joint work of the Survey and the census. In 1890 the total production of coal in the United States amounted to 157,770,963 short tons, which was then considered a large tonnage and was the record-making output up to that time. This tonnage appears small, however, when compared with that of over 500,000,000 short tons made in 1910, just 20 years later. In the production of bituminous coal alone the State of Pennsylvania in 1910 nearly equaled the total production of the United States in 1890, and in the combined production of bituminous coal and anthracite, Pennsylvania in 1910 exceeded the total output of 1890 by nearly 50 per cent.

Although the production in 1910 showed a substantial increase over 1909 and established a new record for the industry, there was nothing in the nature of a boom except in those districts which benefited by the strike of five and a half months in Illinois, Missouri, Kansas, Oklahoma, and Arkansas. This strike resulted in decreased production in the States affected, but the shortage was more than made up by the increased output in other States. Except for this strike, the details of which are discussed in the subsequent pages of this report, the industry in 1910 was without special incident.

ACKNOWLEDGMENTS.

The statistics of coal production, as those of other branches of the mining industry, are compiled from direct returns by the operators. They could not be secured in the completeness in which they are without the hearty good will and cooperation of the corporations, firms, and individuals engaged in the industry, and the author desires to reiterate and emphasize his appreciation of the assistance received from these sources. Acknowledgments are also due to the State geological surveys of Alabama, Georgia, Illinois, Iowa, Kansas, Kentucky, Maryland, Michigan, Oregon, and Virginia for efficient cooperation in the collection of the statistics in those States, and to the secretaries of boards of trade or other local authorities for contributions on the coal trade of some of the principal cities. Recognition for these contributions is also given in connection with their contributions under the caption "Coal trade review." Not the least of the writer's acknowledgments are those due to his faithful and efficient clerical and stenographic assistants in the United States Geological Survey.

A special feature of the present chapter is a brief description of the coal fields in each of the producing States. These contributions have been prepared by members of the Survey's geologic staff and are accompanied by maps showing the coal areas. Acknowledgments are due to Marius R. Campbell, David White, G. C. Martin, R. W. Stone, Chas. Butts, Henry Hinds, Carl D. Smith, J. S. Diller, W. T. Lee, C. T. Lupton, and E. W. Shaw.

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.

SUMMARY OF STATISTICS IN 1910.

Total production in 1910, 501,596,378 short tons; spot value, $629,557,021.

Pennsylvania anthracite.—Total production in 1910, 75,433,246 long tons (equivalent to 84,485,236 short tons); spot value, $160,275,302.

Bituminous coal and lignite.—Total production in 1910, 417,111,142 short tons; spot value, $469,281,719.

Production.—For the first time in the history of the United States, the coal mines of the country were credited in 1910 with an outturn exceeding half a billion short tons, the combined production of anthracite, bituminous coal, and lignite having amounted to 501,576,895 short tons. This great output was attained in spite of the fact that most of the mines in Illinois, Missouri, Kansas, Arkansas, and Oklahoma were closed down for nearly six months by one of the most bitterly contested strikes in the history of the industry. The heaviest tonnage mined in any year prior to 1910 was in 1907, when a total of 480,363,424 short tons was produced. The production in 1910 exceeded the previous high record by 21,213,471 short tons.

Compared with 1909, when the production amounted to 460,814,616 short tons, the output in 1910 showed an increase of 40,781,762 short tons, or 8.85 per cent. Prices generally were a little higher in 1910 than in 1909, the average for Pennsylvania anthracite being $2 13 per long ton, against $2.06 in 1909, and the average for bituminous coal being $1.12 per short ton in 1910, against $1.07 in 1909. The total value increased from $554,668,364 in 1909 to $629,557,021, or 13.50 per cent.

Increase and decrease.—Except for the States affected by the strike order, the increase in production was general among the more important States. The output of anthracite in Pennsylvania increased from 72,384,249 long tons[1] (or 81,070,359 short tons), valued at $149,181,587, to 75,433,246 long tons (84,485,236 short tons), valued at $160,275,302, a gain of 3,048,997 long tons (3,414,877 short tons), or 4.21 per cent, in quantity and of $11,093,715, or 7.44 per cent, in value. Bituminous production, including semianthracite, semibituminous, cannel, splint, and subbituminous coals, lignite, and a small quantity of anthracite from Colorado and New Mexico, increased from 379,744,257 short tons, valued at $405,486,777, to 417,111,142 short tons, valued at $469,281,719, a gain of 37,366,885 short tons, or 9.84 per cent, in quantity and of $63,794,942, or 15.73 per cent, in value.

The total increase of 40,781,762 short tons in 1910 over 1909 was equal to 20 per cent more than the entire output of the United States in 1870, more than half of the total output in 1880, and more than one-fourth of the total output in 1890.

The most important increases in production in 1910 were in the States that benefited from the idleness in the Mississippi Valley States. The largest increase in tonnage was made by the bituminous coal mines of Pennsylvania, 12,554,735 short tons; West Virginia was second with an increase of 9,821,799 short tons; Ohio, third, increased 6,270,027 tons; Kentucky, fourth, increased 3,925,935 tons; Indiana, fifth, 3,555,556 tons; and Alabama, sixth, 2,408,012 tons. The distinction of having the largest percentage of increase belongs to Virginia, with Kentucky a close second. Virginia's percentage of increase was 36.95, and Kentucky's was 36.7; but in quantity Kentucky's increase was more than double that of Virginia.

Of the 29 States in which coal was produced in 1909 and 1910, there were 17 in which the output in 1910 was larger than in 1909 and 12 in which production decreased. The largest decreases were naturally in those States most affected by the strike order, namely, Arkansas, Illinois, Kansas, Michigan, Missouri, and Oklahoma, the aggregate tonnage for these six States being 9,037,943 tons less in 1910 than it was in 1909, whereas the total decrease for the 12 States was 9,151,220 tons.

The year 1910, in addition to having the largest tonnage on record, was one of generally higher values. With only one or two minor exceptions, the percentage of increase in value was larger than that of the increase in tonnage in the States where gains were shown, and the percentage of decrease in value was the smaller where a loss in tonnage was shown. In 1909 prices were lower than for several years. History is constantly repeating itself in coal mining as in other lines of industry, and in the somewhat inflated conditions of 1906 and 1907 owners of undeveloped coal lands were impelled to get the mines opened up, regardless of the fact that the capacity of the

[1] The production of Pennsylvania anthracite as given in the report for 1909 was 10,000 long tons less than this quantity. After the report for 1909 had been printed a belated schedule was received from a river dredge that recovered 10,000 tons in that year.

developed properties in the United States was and is from 50 to 75 per cent in excess of the actual production. The effect of this was not shown so much in the returns for 1908, for while the production in that year was nearly 65,000,000 tons less than in 1907 the average price was unchanged. It must be remembered, however, that in off years when production is in excess of the demand consumers are more exacting in their requirements and operators are not so well able to dispose of the slack and other undesirable grades of coal. It frequently happens, therefore, that in times of depression the prices will appear at a higher level than when more prosperous conditions prevail. The returns to the operators may be, however, less remunerative because of the larger quantities of slack thrown on the dumps. These factors must all be considered in any study of rise and fall in the price of coal.

It should also be remembered that the small sizes of anthracite which are sold for making steam, 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.

Growth by decades.—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 continued 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 10 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 from 1906 to 1910, inclusive, was 454,554,879 short tons, showing an increase of 171,314,604 short tons, or 60.5 per cent.

Growth and population.—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 50 years, or to the middle of the last century, and comparing the statistics of coal production with the increased population, one finds 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. Ten years later, in 1860, 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, in 1880, 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 report of the Thirteenth Census on population shows that on April 15, 1910, the United States contained 91,972,266 persons, indicating that the per capita coal production in that year was nearly 5.5 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 is probably as great to-day, or possibly greater than it was 50 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, and natural gas still remains an important factor in this regard. The consumption of petroleum for fuel in 1909 was probably equivalent to between 20,000,000 and 25,000,000 short tons of coal.

Men and machinery.—The coal mines of the United States gave employment to 725,030 men, of whom 169,497 were employed in the anthracite mines of Pennsylvania, and 555,533 were employed in the bituminous and lignite mines. The anthracite workers averaged 229 days during the year, and the bituminous and lignite averaged 217 days, the general average being 220 days. The average production per man in the anthracite mines was 498 short tons for the year and 2.17 tons for each working day, and in the bituminous and lignite mines the average production per man was 751 tons for the year and 3.46 tons for each working day. The statistics of labor employed in 1909, which were collected by the Bureau of the Census, were not compiled in a manner that furnishes comparisons with the statistics compiled by the Geological Survey.

In 1908 there were 690,438 men employed, 174,174 in the anthracite mines and 516,264 in the bituminous and lignite mines. In that year the average production per man in the anthracite region was 478 tons for the year and 2.39 tons per day, and in the bituminous and lignite mines these averages were, respectively, 644 tons and 3.34 tons.

It is doubtful if the great tonnage record made in the production of bituminous coal by the United States in recent years could have been attained with the supply of labor available and at the low prices which have obtained except for the introduction of labor-saving machinery. In this the greatest part has been played by the machines used for undercutting and shearing the coal. In many cases the installation of machinery has been forced upon the operators in order to meet the constantly increasing competition combined with advances in wages, and yet it also happens that much of the advantage sought to be obtained has been lost through the differentials in mining rates placed against the machines. More important than the lessening of the mining cost, however, is the reduction of liability to accident by decreasing the proportion of coal "shot from the solid." This reprehensible practice of making the powder do the work, in addition to increasing the danger from explosions and fires, weakens the roof and pillars and produces an inordinate quantity of undesirable or unmarketable fuel. Every step taken to eradicate this evil is a step in advance.

The total quantity of bituminous coal and lignite mined by the use of machines in 1910 was 174,012,293 short tons, or 41.7 per cent of the total. In 1909 the machine-mined production amounted to 142,496,878 short tons, or 37.5 per cent of the total output of bituminous coal and lignite. (None of the anthracite product is undercut either by hand or machinery. It is all shot from the solid, and the character of the coal does not permit of any other method.) The quantity of machine-mined coal in 1910 exceeded that of 1909 by 31,515,415 short tons, or 22.1 per cent, whereas the total production of bituminous coal and lignite showed an increase in 1910 over 1909 of only 9.84 per cent. Over 80 per cent of the total increase in 1910 was in machine-mined coal. The number of machines in use did not show as large an increase as the increase in machine-mined coal, but the statistics indicate a decided advance in the efficiency of the machines employed, and this in turn is to some extent responsible for the increase in the output per man previously mentioned. There were 13,254 machines in use in 1910 against 13,049 in 1909. The average production for each machine increased from 10,920 short tons in 1909 to 13,127 short tons in 1910.

Labor troubles.—So far as labor troubles are concerned, 1910 was in marked contrast to 1909. 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. The spring and summer of 1910 was a period notable for one of the most prolonged labor conflicts that has ever occurred in the bituminous coal mines of the United States. The anthracite fields of Pennsylvania were not affected except in a few unimportant instances, the operators and miners having in 1909 renewed for a third term of three years the awards of the Anthracite Coal Strike Commission of 1902–3. The center of the disturbance of 1910 was in the bituminous fields of Illinois and the Southwestern States, in the Irwin-Greensburg district of Pennsylvania, and to less extent in Iowa and Michigan.

The total number of men on strike in the bituminous mines was 215,640, out of a total of 555,533. The average time lost by each man was 89 days, and the total time lost was equivalent to 19,234,785 working days. At $1.50 a day for each man the loss in wages would amount to nearly $30,000,000, though of course part of this was made up by the increased intensity of labor both before and after the strike. The details are discussed in another portion of this report and in connection with the production of the several States.

Accidents.—The present chapter differs from some of the preceding chapters of the series in that it contains no general statement regarding the number and character of the accidents in the coal mines of the United States. This investigation has been taken up by the United States Bureau of Mines in connection with its mine-rescue work, and the statistics of coal-mine accidents for 1910 will be published by that bureau. For the States in which the statistics have been compiled by the mine inspectors and reported to the Geological Survey through the Bureau of Mines, the total number of fatal and nonfatal accidents, the death rate per thousand of employees, and the quantity of coal mined for each life lost are reported in the discussion of the coal production in those States.

Washed coal.—The production of anthracite in Pennsylvania includes a considerable quantity of coal recovered from the old culm banks by washers. The production of 1910 includes 3,296,318 long tons of fuel thus recovered, against 3,694,470 long tons of washery recovered coal in 1909. In addition to the washery product there were 91,833 long tons in 1910 and 96,239 long tons in 1909 recovered from the bottom of Susquehanna River by means of dredges. The washery product of 1910 was smaller than in any year since 1906, the decrease in this item being probably due to the gradual disappearance of the culm banks.

A considerable quantity of bituminous coal is washed each year, most of this being the slack coal used in the manufacture of coke. In Illinois, however, the larger part of the coal washed is nut coal and is sold to the domestic trade. The total quantity of bituminous coal washed in 1910 was 18,395,382 short tons, an increase of about 1,853,500 short tons over 1909. The washing process yielded in 1910, 16,035,387 tons of cleaned coal and 2,359,995 short tons of refuse. A little over one-third of the total quantity of coal washed was Alabama coal, used for coke making. One-fourth of the total was Pennsylvania coal, and most of this was also used in coke making. In Illinois the quantity of coal washed (principally for domestic use) was 2,453,208 tons.

Consumption.—Practically the entire output of both anthracite and bituminous coal in the United States is consumed within the country. The effort on the part of some of the operators in the Eastern States to build up an export trade has resulted in a considerable expansion of business along this line of some importance in itself but of comparative insignificance when considered with the total production. The total quantity of coal exported in 1910 was 15,462,570 short tons, or a little over 3 per cent of the production. The consumption of coal of domestic production—that is, the total production less the quantity exported—of 1910 was 486,133,808 short tons. The imports amounted in 1910 to 1,686,612 short tons, which, added to the consumption of domestic coal, made the total consumption in that year 487,820,420 short tons, which is equivalent to 97.25 per cent of the domestic production. In this statement no account is taken of the stock on hand at the beginning and the end of the year. The coal-mining industry is at best of a hand-to-mouth character, and stocks do not figure in the trade.

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 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 1910 was 52,187,450 short tons, as compared with 48,677,611 short tons in 1909, an increase in 1910 of 3,509,839 short tons, or 7.21 per cent, as compared with an increase of 8.85 per cent in the total production of coal. The coal shipped to market, used in the manufacture of coke, and sold locally amounted in 1910 to 483,087,320 short tons, as compared with 442,679,410 short tons in 1909. This is usually considered the marketable product. Colliery consumption, which represents the difference between the marketable product and the total output, amounted in 1910 to 18,509,058 short tons. The colliery consumption in the anthracite region, consisting almost entirely of culm or waste material, averages something over 10 per cent of the total anthracite production. In 1910, out of a total production of 75,433,246 long tons, 7,894,140 tons were used in the mines for steam and heat. The colliery consumption in a bituminous region amounts to within 2 to 3 per cent of the total output, and in 1910 out of a total of 417,111,142 short tons, 9,667,621 short tons were used in the operation of the properties.

PRODUCTION.

STATISTICS FOR 1910.

The statistics of the production of coal in the United States in 1909 and 1910, by States, with the distribution of the product for consumption, are shown in the tables following.

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	70,221,195	2,201,997	8,647,167		81,070,359	149,181,587	1.84	166,801
Grand total	379,840,080	14,161,719	18,135,206	48,677,611	460,814,616	554,668,364	1.20	666,555

[a] Preliminary figures compiled by Bureau of the Census.

Coal production of the United States in 1910, 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	10,843,811	206,201	644,007	4,417,443	16,111,462	$20,236,853	$1.26	249	22,230
Arkansas	1,822,022	13,112	70,824		1,905,958	2,979,213	1.56	128	5,568
California and Alaska	6,679	4,985	500		12,164	33,336	2.74	189	19
Colorado	9,563,063	295,164	330,517	1,784,992	11,973,736	17,026,934	1.42	236	15,864
Georgia	94,330	776	2,760	79,379	177,245	259,122	1.46	265	386
Idaho	100	4,348			4,448	17,426	3.92	200	14
Illinois	41,818,730	2,666,614	1,400,352	14,550	45,900,246	52,405,897	1.14	160	72,645
Indiana	17,226,134	771,728	391,953		18,389,815	20,813,659	1.13	229	21,878
Iowa	7,169,039	588,871	170,210		7,928,120	13,903,913	1.75	218	16,666
Kansas	4,574,731	202,472	143,657	591	4,921,451	7,914,709	1.61	148	12,870
Kentucky	13,665,010	528,987	332,731	96,591	14,623,319	14,405,887	.99	221	20,316
Maryland	5,097,347	62,760	57,018		5,217,125	5,835,058	1.12	270	5,809
Michigan	1,355,819	110,473	68,675		1,534,967	2,930,771	1.91	211	3,575
Missouri	2,512,492	413,570	56,371		2,982,433	5,328,285	1.79	154	9,691
Montana	2,657,087	101,613	124,751	37,519	2,920,970	5,329,322	1.82	239	3,837
New Mexico	2,720,641	40,428	46,048	701,204	3,508,321	4,877,151	1.39	283	3,585
North Dakota	269,037	119,377	10,627		399,041	595,139	1.49	207	534
Ohio	31,958,985	1,684,444	560,290	5,949	34,209,668	35,932,288	1.05	203	46,641
Oklahoma	2,435,987	50,821	153,647	5,771	2,646,226	5,867,947	2.22	144	8,657
Oregon	40,497	13,583	13,453		67,533	235,229	3.48	257	153
Pennsylvania, bituminous	108,600,585	2,985,188	3,202,352	35,733,401	150,521,526	153,029,510	1.02	238	175,403
Tennessee	6,255,707	132,750	117,365	615,558	7,121,380	7,925,350	1.11	225	11,930
Texas	1,843,356	20,702	28,118		1,892,176	3,160,965	1.67	234	4,197
Utah	2,129,452	26,207	94,345	267,805	2,517,809	4,224,556	1.68	260	3,053
Virginia	4,063,382	88,284	147,621	2,208,710	6,507,997	5,877,486	.90	241	7,264
Washington	3,522,347	140,931	154,579	94,042	3,911,899	9,764,465	2.50	256	6,314
West Virginia	53,562,518	923,914	1,060,642	6,123,945	61,671,019	56,665,061	.92	228	68,663
Wyoming	7,160,332	88,548	284,208		7,533,088	11,706,187	1.55	248	7,771
Total bituminous	342,969,220	12,286,851	9,667,621	52,187,450	417,111,142	469,281,719	1.12	217	555,533
Pennsylvania, anthracite	73,623,227	2,020,572	8,841,437		84,485,236	160,275,302	1.90	229	169,497
Grand total	416,592,447	14,307,423	18,509,058	52,187,450	501,596,378	629,557,021	1.25	220	725,030

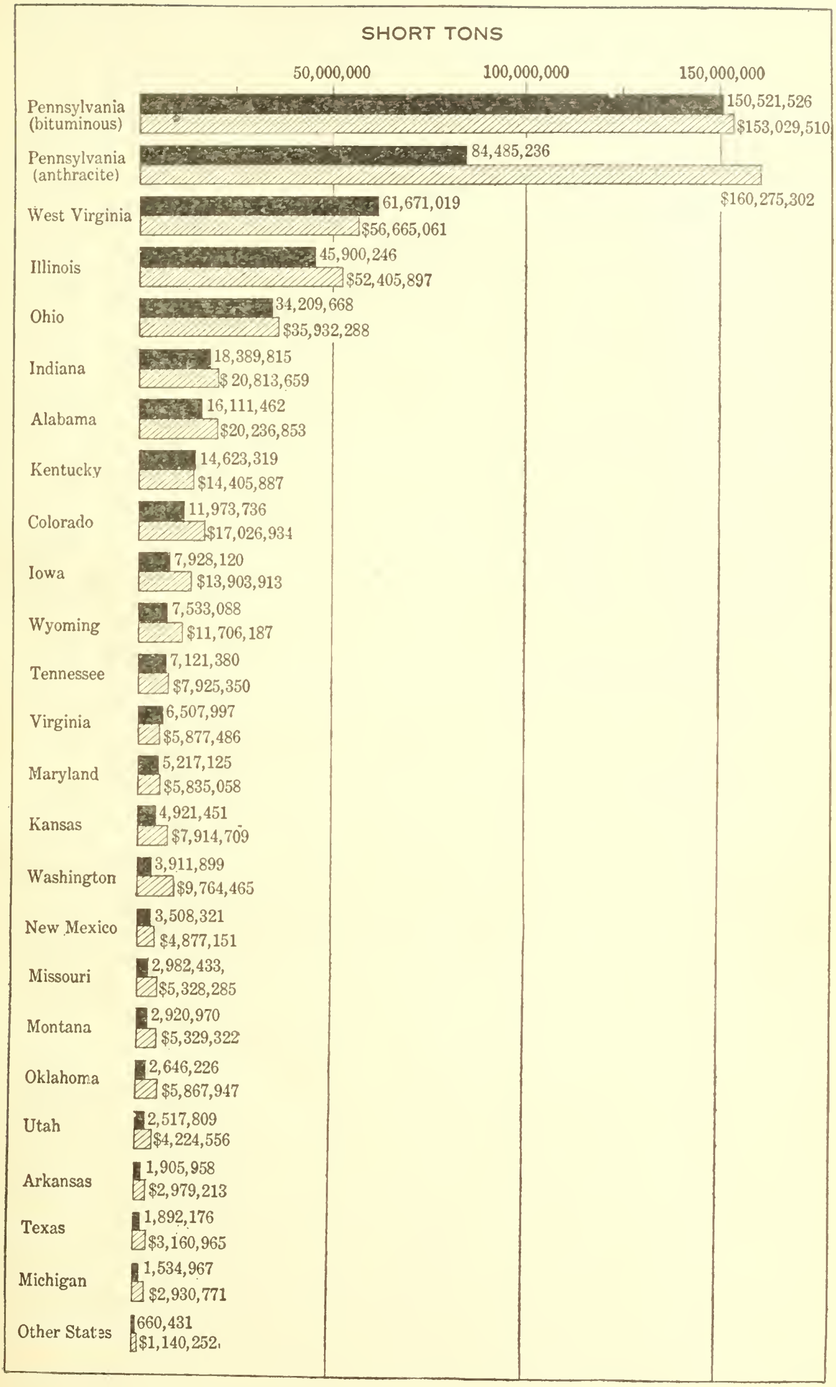


FIGURE 1.—Production of coal in the United States in 1910, by States.

The number of States in which coal was produced in 1910 was 29, the same as in 1909. Comparison of the two years shows that there were 17 States in which the production in 1910 exceeded that of 1909 and 12 States in which the production decreased. The important factor influencing the production in 1910 was the strike in the mines of Illinois and in the Southwestern States of Arkansas, Kansas, Missouri, and Oklahoma. The strike order affected also the mines in Michigan. Of the aggregate decrease of 9,151,220 short tons, the 5 States mentioned were responsible for 9,037,943 tons, or 98.8 per cent. Six States in which decreases also occurred were California, Alaska, Georgia, Idaho, North Dakota, and Oregon; the decrease in these 6 States aggregated 113,277 short tons, or only 1.2 per cent of the total decrease. Of the 5 States most seriously affected by the strike, Illinois suffered most in loss of tonnage, and Kansas suffered the largest percentage of loss. The decrease in the production of Illinois was 5,004,744 short tons, or over 50 per cent of the total decrease. The decrease in Kansas amounted to 2,065,027 short tons, or 29.56 per cent as compared with 1909, whereas the comparative percentage of loss in Illinois was 9.83 per cent. The decreases in California and Oregon were due to the demoralization of the coal-mining industry through the great increase in the production and use of crude petroleum for fuel. Georgia's decrease was due to the inability of the operators to secure free labor to take the place of the convicts, who have been withdrawn by the State and upon whose labor the operators formerly relied.

The principal increases were in the production of bituminous coal in Pennsylvania, West Virginia, Ohio, Kentucky, and Indiana, all of which being States competitive with Illinois and the Southwestern States, reaped the benefit of the strike. The production of Pennsylvania bituminous coal increased 12,554,735 short tons, or 9.1 per cent. West Virginia increased in its production 9,821,799 short tons, or 18.94 per cent, and established itself firmly as second in importance among the coal-producing States, Illinois having dropped to third place, with a production less than that of West Virginia by over 15,000,000 tons. Ohio's production gained 6,270,027 short tons, or 22.44 per cent. Of the 5 States showing the greatest increases in production, Kentucky showed the largest percentage of gain, the output of the State having increased 3,925,935 short tons, or 36.7 per cent. Indiana's production increased 3,555,556 tons, or 24 per cent. Other important increases were made by Alabama, Virginia, Colorado, Maryland, and Wyoming. The production of Pennsylvania anthracite increased from 72,384,249 long tons (or 81,070,359 short tons), valued at $149,181,587, in 1909 to 75,433,246 long tons (or 84,485,236 short tons), valued at $160,275,302. The total production of bituminous coal, including lignite, increased from 379,744,257 short tons, valued at $405,486,777 in 1909, to 417,111,142 short tons, valued at $469,281,719, in 1910. The increase in the production of anthracite was 3,048,997 long tons (or 3,414,877 short tons), or 4 per cent in quantity, and $11,093,715, or 7.4 per cent in value. The increase in the bituminous production, the bituminous coal including lignite, was 37,366,885 short tons, or 9.84 per cent in quantity and $63,794,942, or 15.73 per cent in value.

In the following table is presented a statement of the total production of coal in the United States in the last five years, by States, with the increases and decreases in 1910 as compared with 1909:

Quantity and value of coal produced in the United States, 1906–1910, in short tons.

State or Territory.	1906 Quantity.	1906 Value.	1907 Quantity.	1907 Value.
Alabama	13,107,963	$17,514,786	14,250,454	$18,405,468
Arkansas	1,864,268	3,000,339	2,670,438	4,473,693
California and Alaska	30,831	78,684	24,089	91,813
Colorado	10,111,218	12,735,616	10,790,236	15,079,449
Georgia and North Carolina	[a] 332,107	[a] 424,004	[a] 362,401	[a] 499,686
Idaho	[b] 6,165	[b] 24,238	[c] 7,588	[c] 31,119
Illinois	41,480,104	44,763,062	51,317,146	54,687,382
Indiana	12,092,560	13,116,261	13,985,713	15,114,300
Indian Territory (Oklahoma)	2,860,200	5,482,366	3,642,658	7,433,914
Iowa	7,266,224	11,619,455	7,574,322	12,258,012
Kansas	6,024,775	8,979,553	7,322,449	11,159,698
Kentucky	9,653,647	9,809,938	10,753,124	11,405,038
Maryland	5,435,453	6,474,793	5,532,628	6,623,697
Massachusetts	....	....	....	....
Michigan	1,346,338	2,427,404	2,035,858	3,660,833
Missouri	3,758,008	6,118,733	3,997,936	6,540,709
Montana	1,829,921	3,240,357	2,016,857	3,907,082
New Mexico	1,964,713	2,638,986	2,628,959	3,832,128
North Dakota	305,689	451,382	347,760	560,199
Ohio	27,731,640	30,346,580	32,142,419	35,324,746
Oregon	79,731	212,338	70,981	166,304
Pennsylvania bituminous	129,293,206	130,290,651	150,143,177	155,664,026
Tennessee	6,259,275	7,667,415	6,810,243	8,490,334
Texas	1,312,873	2,178,901	1,648,069	2,778,811
Utah	1,772,551	2,408,381	1,947,607	2,959,769
Virginia	4,254,879	4,183,991	4,710,895	4,807,533
Washington	3,276,184	5,908,434	3,680,532	7,679,801
West Virginia	43,290,350	41,051,939	48,091,583	47,846,630
Wyoming	6,133,994	8,013,528	6,252,990	9,732,668
Total bituminous	342,874,867	381,162,115	394,759,112	451,214,842
Pennsylvania anthracite	71,282,411	131,917,694	85,604,312	163,584,056
Grand total	414,157,278	513,079,809	480,363,424	614,798,898

State or Territory.	1908 Quantity.	1908 Value.	1909 Quantity.	1909 Value.
Alabama	11,604,593	$14,647,891	13,703,450	$16,306,236
Arkansas	2,078,357	3,499,470	2,377,157	3,523,139
California and Alaska	21,862	69,650	48,636	107,342
Colorado	9,634,973	13,586,988	10,716,936	14,296,012
Georgia and North Carolina	264,822	364,279	211,196	298,792
Idaho	5,429	21,832	4,553	19,459
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
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
Kentucky	10,246,553	10,317,162	10,697,384	10,079,917
Maryland	4,377,093	5,116,753	4,023,241	4,471,731
Massachusetts	50	150	....	....
Michigan	1,835,019	3,322,904	1,784,692	3,199,351
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
New Mexico	2,467,937	3,368,753	2,801,128	3,619,744
North Dakota	320,742	522,116	422,047	645,142
Ohio	26,270,639	27,897,704	27,939,641	27,789,010
Oklahoma (Indian Territory)	2,948,116	5,976,504	3,119,377	6,253,367
Oregon	86,259	236,021	87,276	235,085
Pennsylvania bituminous	117,179,527	118,816,303	137,966,791	130,085,237
Tennessee	6,199,171	7,118,499	6,358,645	6,920,564
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
Virginia	4,259,042	3,868,524	4,752,217	4,251,056
Washington	3,024,943	6,690,412	3,602,263	9,158,999
West Virginia	41,897,843	40,009,054	51,849,220	44,661,716
Wyoming	5,489,902	8,868,157	6,393,109	9,896,848
Total bituminous	332,573,944	374,135,268	379,744,257	405,486,777
Pennsylvania anthracite	83,268,754	158,178,849	81,070,359	149,181,587
Grand total	415,842,698	532,314,117	460,814,616	554,668,364

[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, 1906–1910, in short tons—Con.

State or Territory.	1910		Increase (+) or decrease (−), 1910.		Percentage of increase or decrease, 1910.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Alabama	16,111,462	$20,236,853	+ 2,408,012	+$3,930,617	+17.57	+24.10
Arkansas	1,905,958	2,979,213	− 471,199	− 543,926	−19.82	−15.44
California and Alaska	12,164	33,336	− 36,472	− 74,006	−74.99	−68.94
Colorado	11,973,736	17,026,934	+ 1,256,800	+ 2,730,922	+11.73	+19.10
Georgia	177,245	259,122	− 33,951	− 39,670	−16.08	−13.28
Idaho	4,448	17,426	− 105	− 2,033	− 2.31	− 1.04
Illinois	45,900,246	52,405,897	− 5,004,744	− 1,116,117	− 9.83	− 2.09
Indiana	18,389,815	20,813,659	+ 3,555,556	+ 5,658,978	+23.97	+37.34
Iowa	7,928,120	13,903,913	+ 170,358	+ 1,110,285	+ 2.20	+ 8.68
Kansas	4,921,451	7,914,709	− 2,065,027	− 2,168,675	−29.56	−21.51
Kentucky	14,623,319	14,405,887	+ 3,925,935	+ 4,325,970	+36.70	+42.92
Maryland	5,217,125	5,835,058	+ 1,193,884	+ 1,363,327	+29.67	+30.49
Michigan	1,534,967	2,930,771	− 249,725	− 268,580	−13.99	− 8.39
Missouri	2,982,433	5,328,285	− 774,097	− 855,341	−20.61	−13.83
Montana	2,920,970	5,329,322	+ 367,030	+ 292,380	+14.37	+ 5.80
New Mexico	3,508,321	4,877,151	+ 707,193	+ 1,257,407	+25.25	+34.74
North Dakota	399,041	595,139	− 23,006	− 50,003	− 5.45	− 7.75
Ohio	34,209,668	35,932,288	+ 6,270,027	+ 8,143,278	+22.44	+29.30
Oklahoma	2,646,226	5,867,947	− 473,151	− 385,420	−15.17	− 6.16
Oregon	67,533	235,229	− 19,743	+ 144	− 2.62	+ .06
Pennsylvania bituminous	150,521,526	153,029,510	+12,554,735	+22,944,273	+ 9.10	+17.64
Tennessee	7,121,380	7,925,350	+ 762,735	+ 1,004,786	+12.00	+14.52
Texas	1,892,176	3,160,965	+ 67,736	+ 19,020	+ 3.71	+ .60
Utah	2,517,809	4,224,556	+ 250,910	+ 472,746	+11.07	+12.60
Virginia	6,507,997	5,877,486	+ 1,755,780	+ 1,626,430	+36.95	+38.26
Washington	3,911,899	9,764,465	+ 309,636	+ 605,466	+ 8.60	+ 6.61
West Virginia	61,671,019	56,665,061	+ 9,821,799	+12,003,345	+18.94	+26.88
Wyoming	7,533,088	11,706,187	+ 1,139,979	+ 1,809,339	+17.83	+18.28
Total bituminous	417,111,142	469,281,719	+37,366,885	+63,794,942	+ 9.84	+15.73
Pennsylvania anthracite	84,485,236	160,275,302	+ 3,414,877	+11,093,715	+ 4.21	+ 7.44
Grand total	501,596,378	629,557,021	+40,781,762	+74,888,657	+ 8.85	+13.50

The great advances made in the production of coal during recent years have been principally in the output of bituminous coal. The maximum production of Pennsylvania anthracite was obtained in 1907, when a total of 76,432,421 long tons, or 85,604,312 short tons, was produced. It is believed by many that the present production of approximately 75,000,000 long tons annually in the anthracite region of Pennsylvania has about reached its limit, though it is by no means certain that, before the inevitable period of decline begins, a total of 100,000,000 long tons may not be reached. The present production of anthracite in Pennsylvania is about 50 per cent more than it was 20 years ago, in 1891, and this rate of increase compares favorably with that of Great Britain, whose total production in 1910 showed an increase of less than 50 per cent over that of 1891. Germany's production in 1910 was about one and one-third times what it was in 1891. The rate of increase in the French production is about the same as that of Great Britain and of anthracite in Pennsylvania, but all of these, when compared with the rate of increase in the production of bituminous coal in the United States, appear insignificant. The production of bituminous coal in the United States in 1910 exceeded that of 1891 by more than 300,000,000 tons, or nearly 200 per cent. The production of anthracite in 1910 was almost exactly 1,000,000 long tons less than the maximum production of 1907, while the production of bituminous coal in 1910 exceeded that of the maximum output of 1907 by 22,350,000 short tons. The average annual production of anthracite coal in 1906 to 1910, inclusive, was 72,448,405 long tons, against an annual average of 59,690,873 long tons from 1901 to 1905, inclusive. The latter period included the year of the great strike, 1902, in which the production fell off about 24,000,000 tons. The average annual production of bituminous coal in the last five years has amounted to 373,412,644 short tons, against 272,503,363 short tons as the average annual production for the five years from 1901 to 1905.

The accompanying diagram (fig. 2) illustrates the comparative growth in the production of anthracite and bituminous coal from 1856 to 1910. Prior to 1870 the larger portion of the production was in Pennsylvania anthracite, but since 1870 the output of bituminous coal has rapidly outstripped that of anthracite. In 1869 the production of Pennsylvania anthracite was 17,083,134 short tons and the production of bituminous coal was 15,821,226 tons. In the census year of 1870 these figures were nearly reversed, and at the following census of 1880 the production of anthracite amounted to 28,649,812 short tons, and that of bituminous to 42,831,758 short tons. In 1890 the production of anthracite had grown to 46,468,641 short tons, whereas the bituminous production amounted to 111,302,322 short tons. In the next 10 years the production of anthracite increased 23.5 per cent and amounted to 57,367,915 short tons, and the bituminous production increased 91 per cent to 212,316,112 short tons. The statistics for 1910 show that the output of anthracite amounted to 84,485,236 short tons, an increase over 1900 of 27,117,321 short tons, or 47.3 per cent. The production of bituminous coal increased 204,795,030 tons, or 96.5 per cent. The production of anthracite coal in 1910 was nearly three times that of 1880 and the production of bituminous was nearly ten times.

The reason for more rapid advance in the production of bituminous coal is the disappearance of anthracite as a fuel for manufacturing purposes. The rate of increase in the production of anthracite is not materially different from the increase in population. The increase in the production of bituminous coal has been more in keeping with the advance in manufactures and transportation, and consequently out of all proportion to the increase in population.

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 1910, 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

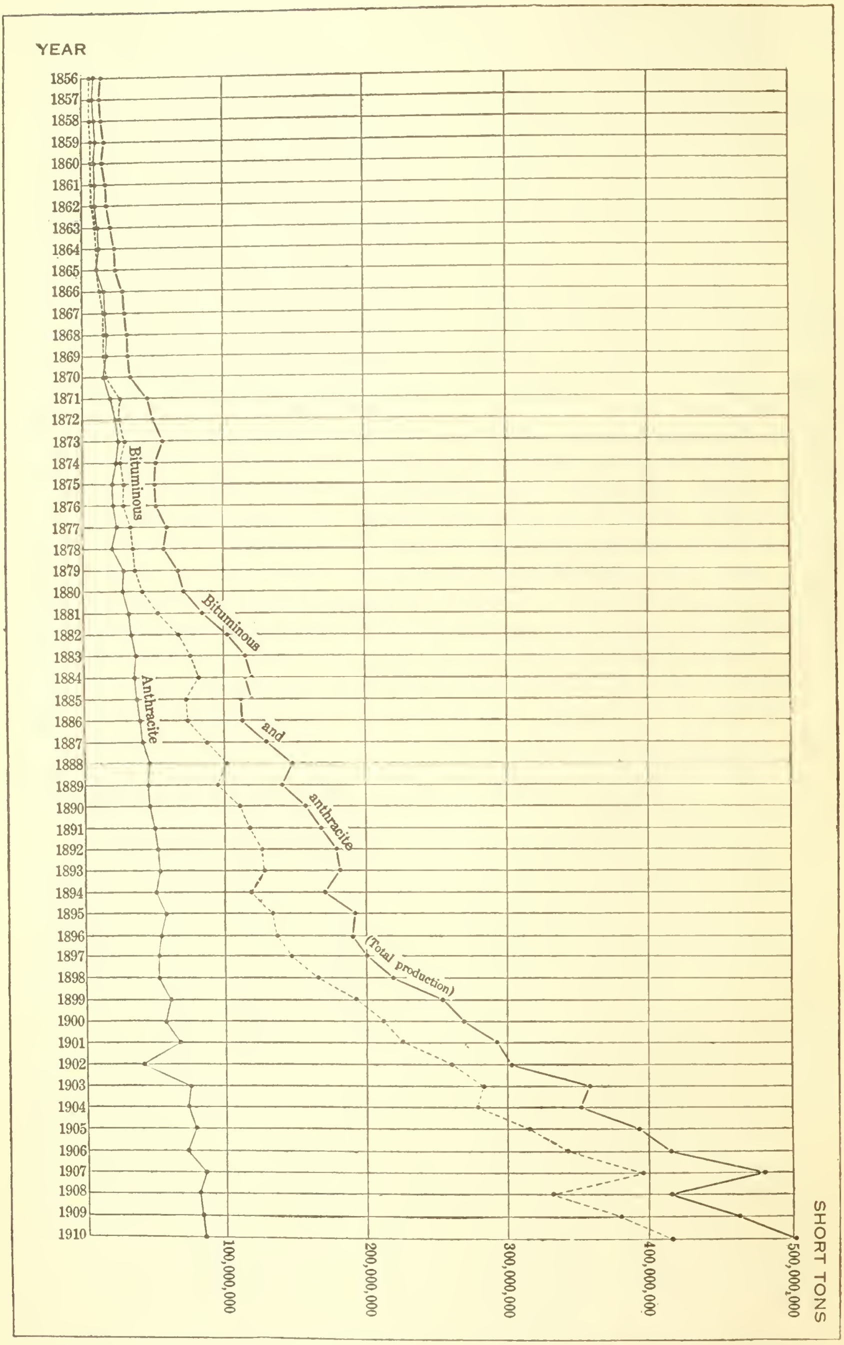


FIGURE 2.—Yearly production of anthracite and bituminous coal from 1856 to 1910, in short tons.

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 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 steadier 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 1905–1910, 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	379,840,080	14,161,719	18,135,206	48,677,611
1910	416,592,447	14,307,423	18,509,058	52,187,450

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	460,814,616	554,668,364	1.20	....	666,555
1910	501,596,378	629,557,021	1.25	220	725,030

Production of coal in the United States, 1880, 1885, 1890, 1895, and 1900–1910.

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	72,384,249	81,070,359	149,181,587	339,057,372	379,744,257	405,486,777
1910	75,433,246	84,485,236	160,275,302	372,420,663	417,111,142	469,281,719

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	411,441,621	460,814,616	554,668,364
1910	447,853,909	501,596,378	629,557,021

The following table has been prepared to show how the production of Pennsylvania, West Virginia, Illinois, Ohio, and Alabama, five of the leading coal-mining States, has grown in comparison with the total production since 1860. The statistics are for each 10 years from 1860 to 1900 and annually from 1901 to 1910, inclusive. In the first year of these series, 1860, Pennsylvania produced nearly three-fourths (74 per cent) of the total output of the United States, but has produced less than 50 per cent in each of the last nine years. This decline in relative importance has not been due to any decline in the coal-mining industry of Pennsylvania, but to the more rapid increase which has taken place in some of the more recently developed States. West Virginia, which was not a separate State in 1860, produced less than 2 per cent of the total output 10 years later and subsequent to its admission as a State. In 1910 West Virginia produced 12.3 per cent of the total output. Illinois had more than doubled its proportion in 1906, 1907, 1908, and 1909 as compared with 1860, but on account of the loss due to the strike in 1910, relatively declined to 9.2 per cent of the total. Ohio's production has increased, but its percentage of the total in 1910 was 6.8 per cent as compared with 8.7 per cent in 1860. Alabama produced less than one-tenth of 1 per cent in 1860 and 3.2 per cent of the total in 1910.

Alabama's production has apparently kept nearly even with the general increase, as the proportion of the total has averaged about 3 per cent for the last 10 years.

Relative production of Pennsylvania, West Virginia, Illinois, Ohio, and Alabama to total output, 1860–1910, 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	460,814,616	219,037,150	47.5	51,849,220	11.2
1910	501,596,378	235,006,762	46.9	61,671,019	12.3

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
1910	45,900,246	9.2	34,209,668	6.8	16,111,462	3.2

PRODUCTION OF COAL IN THE UNITED STATES FROM THE EARLIEST TIMES TO THE CLOSE OF 1910.

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, Va., about 70 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 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

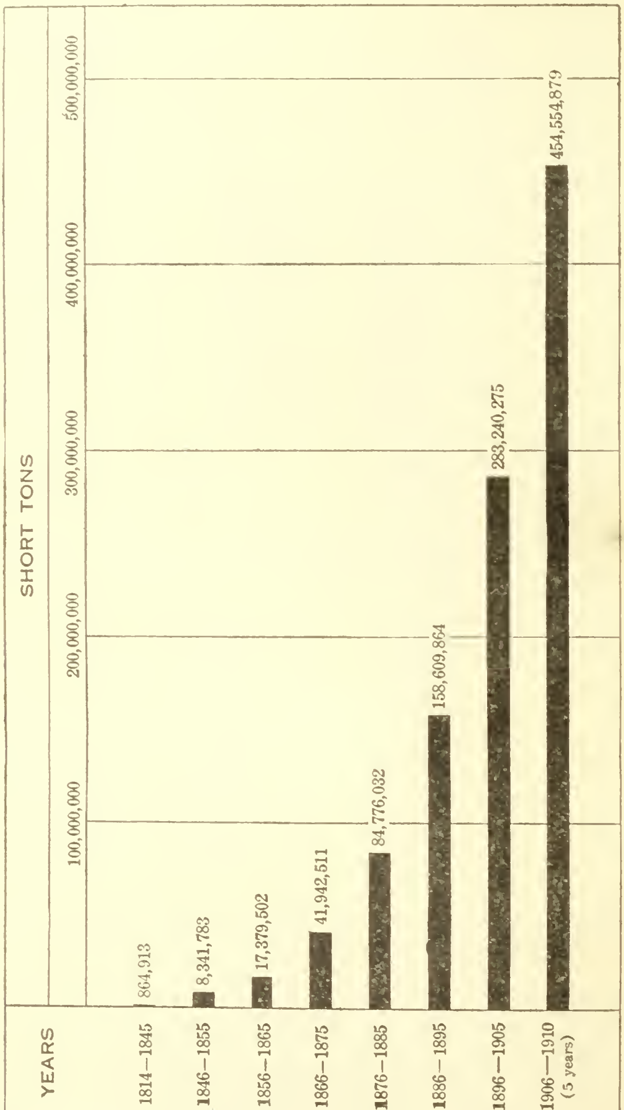


FIGURE 3.—Average yearly production of coal in the United States for each decade since 1814, in short tons.

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.

The following table shows the total production of anthracite in Pennsylvania since 1814, the total production of bituminous coal since 1820, and the total annual production to the close of 1910. During the period covered by this table the total production of anthracite in Pennsylvania has amounted to 2,180,334,670 short tons, that of bituminous coal to 6,063,016,589 short tons, and that of the whole country to 8,243,351,259 short tons. Of the grand total the anthracite mines of Pennsylvania have contributed a little more than 25 per cent, and a little less than 75 per cent is represented by the production of bituminous coal.

The annual production of each State, from the time of earliest record to the close of 1910, is given in connection with the discussion of the production in the several States.

Production of coal in the United States from 1814 to the close of 1910, 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

Year.	Pennsylvania anthracite.	Bituminous.	Total.
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.....	81,070,359	379,744,257	460,814,616
1910.....	84,485,236	417,111,142	501,596,378
	2,180,334,670	6,063,016,589	8,243,351,259

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 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.

The present chapter contains maps showing the known coal areas in all of the important coal-producing States. It has been found advisable in some instances to combine several States. For instance, the coal fields of Illinois, Indiana, and western Kentucky are shown on one map. Those of Maryland, Virginia, and West Virginia on another. In each case where such combinations have been made, the character of the coal and the markets which it supplies have been considered. The report for 1907 contains a map of all the coal fields on a much smaller scale. Copies of the report for 1907 with the accompanying map are still available and may be obtained upon application to the Director of the Geological Survey. The smaller map contains a statement covering the character and the geologic age of the coal and the estimated tonnnage of the various fields. The estimate of tonnage has been slightly revised from more recently collated data. According to the revised estimates, the supply of coal in the ground when mining began was 3,076,204,000,000 short tons, of which 1,922,979,000,000 are considered to be easily accessible. and 1,153,225,000,000 short tons to be either so deep or the beds so thin that they are accessible only with difficulty. Classified according to 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 at the close of 1910 was 8,243,351,259 short tons, which, including the loss involved in the mining and preparation of the coal, represents an exhaustion of 13,395,000,000 tons. The original supply less the exhaustion at the close of 1910, leaves as the apparent supply still available 3,062,808,972,000 tons, or 99.6 per cent of the original supply, or in other words, in all the time since coal mining began in the United States, the draft upon the original supply including loss in mining, has amounted to less than one-half of 1 per cent. The annual rate of exhaustion at the present time as represented by the production of 1910 is 0.025 of 1 per cent of the supply. The quantity of coal still in the ground at the close of 1910 was 6,000 times the production of that year.

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 1910, the total production in each to the close of 1910, and the estimated supply still available.

Coal fields of the United States and their production in 1910.

	Area.[a]	Estimated original supply.	Production in 1910.	Total production to close of 1910.	Total exhaustion to close of 1910.	Estimated available supply.
ANTHRACITE.	*Square miles.*	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*
Pennsylvania	480	21,000,000,000	84,485,236	2,180,334,670	4,360,000,000	16,640,000,000
Colorado and New Mexico	29	(b)	(b)	(b)	(b)	(b)
Total	509	21,000,000,000	84,485,236	2,180,334,670	4,360,000,000	16,640,000,000
BITUMINOUS.[c]						
Eastern province.						
Atlantic coast region:						
Virginia	150	(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	150,521,526	2,251,737,097	3,400,000,000	109,174,000,000
Ohio	12,660	86,028,000,000	34,209,668	581,189,306	872,000,000	85,156,000,000
Maryland	455	8,044,000,000	5,217,125	161,224,007	242,000,000	7,802,000,000
Virginia	1,750	22,500,000,000	6,507,997	72,748,408	109,000,000	22,391,000,000
West Virginia	17,000	150,000,000,000	61,671,019	589,616,621	880,000,000	149,120,000,000
Eastern Kentucky	10,270	67,787,000,000	6,279,024	66,818,596	100,000,000	67,687,000,000
Tennessee	4,400	25,665,000,000	7,121,380	103,983,797	156,000,000	25,509,000,000
Georgia	167	933,000,000	177,245	8,776,959	13,000,000	920,000,000
Alabama	8,430	68,903,000,000	16,111,462	206,153,815	309,000,000	68,594,000,000
Total	69,332	542,434,000,000	287,816,446	4,042,248,606	6,081,000,000	536,353,000,000
Interior province.						
Northern region:						
Michigan	11,000	12,000,000,000	1,534,967	18,997,621	28,500,000	11,971,500,000
Eastern region:						
Indiana	6,500	44,169,000,000	18,389,815	204,979,354	300,000,000	43,869,000,000
Western Kentucky	6,400	36,241,000,000	8,344,295	91,153,234	137,000,000	36,104,000,000
Illinois	35,600	240,000,000,000	45,900,246	790,333,235	1,185,500,000	238,814,500,000
Total	48,500	320,410,000,000	72,634,356	1,086,465,823	1,622,500,000	318,787,500,000
Western and southwestern regions:[e]						
Iowa	12,560	29,160,000,000	7,928,120	164,455,984	247,000,000	28,913,000,000
Missouri	16,700	40,000,000,000	2,982,433	107,674,384	151,000,000	39,849,000,000
Kansas	3,100	7,022,000,000	4,921,451	109,329,641	164,000,000	6,858,000,000
Arkansas	1,684	1,887,000,000	1,905,958	30,117,873	45,000,000	1,842,000,000
Oklahoma	10,000	79,278,000,000	2,646,226	48,558,734	73,000,000	79,205,000,000
Texas	10,200	31,000,000,000	1,892,176	20,056,941	30,000,000	30,970,000,000
Total	54,244	188,347,000,000	22,276,364	480,193,557	710,000,000	187,637,000,000

Rocky Mountain and Northern Great Plains provinces.						
Arizona	30	60,000,000				60,000,000
North Dakota	31,240	500,000,000,000	399,041	3,926,088	6,000,000	499,994,000,000
Montana	34,067	303,060,000,000	2,920,970	32,134,233	48,000,000	303,012,000,000
South Dakota	2,000	10,000,000,000				10,000,000,000
Wyoming	20,568	424,085,000,000	7,533,088	97,234,864	146,000,000	423,939,000,000
Utah	13,130	196,458,000,000	2,517,809	25,468,682	38,000,000	196,420,000,000
Colorado	10,105	371,770,000,000	11,973,736	144,993,981	217,000,000	371,553,000,000
New Mexico	13,331	163,780,000,000	3,508,321	31,102,818	46,600,000	163,733,400,000
Idaho	200	600,000,000	4,448	41,695	63,000	599,937,000
Total	124,671	1,969,813,000,000	28,857,413	334,902,361	501,663,000	1,969,311,337,000
Pacific coast province and Alaska.						
Washington	1,100	20,000,000,000	3,911,899	53,647,802	80,000,000	19,920,000,000
Oregon	230	1,000,000,000	67,533	2,031,460	3,000,000	997,000,000
California	500	1,000,000,000	11,164	5,106,700	7,650,000	992,350,000
Alaska			1,000	44,414		
Total	1,830	22,000,000,000	3,991,596	60,830,376	90,650,000	21,909,350,000
Total production, includung colliery consumption	*f* 310,296	3,076,204,000,000	501,596,378	8,243,351,259	13,395,028,000	3,062,808,972,000

[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.
[e] Including Texas lignite fields of Gulf province.
[f] 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.

In the following table are the statistics of the production of each of the various regions from 1887 to the close of 1910:

Total production of each region, 1887–1910, 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	81,070,359	....	251,630,500	1,784,692
1910	84,485,236	....	287,816,446	1,534,967

	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
1910	72,634,356	22,276,364	28,857,413	3,991,596

[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, 1906, 1907, 1908, 1909, and 1910, compared, in short tons.

Region.	1887		1906		1907		1908	
	Quantity.	Percentage of total.	Quantity.	Percentage of total.	Quantity.	Percentage of total	Quantity.	Percentage of total.
Appalachian	55,888,088	63.11	233,473,524	68.10	266,501,527	67.51	216,499,163	65.10
Eastern	14,478,883	16.50	59,457,660	17.34	71,598,256	18.13	65,774,700	19.78
Western	10,172,634	11.49	23,086,348	6.73	26,856,622	6.80	23,645,983	7.11
Northern	71,461	.08	1,346,338	.39	2,035,858	.52	1,835,019	.55
Rocky Mountain	3,646,280	4.15	22,064,003	6.44	23,929,155	6.06	21,644,307	6.51
Pacific coast	854,308	1.00	3,386,746	.99	3,775,602	.96	3,133,064	.94

Region.	1909		1910		Increase in 1910 over 1887.		Increase in 1910 over 1909.	
	Quantity.	Percentage of total.	Quantity.	Percentage of total.	Quantity.	Percentage.	Quantity.	Percentage.
Appalachian	251,630,500	66.26	287,816,446	69.00	231,928,358	414.99	36,185,946	14.38
Eastern	71,598,795	18.85	72,634,356	17.41	58,155,473	401.66	1,035,561	1.45
Western	25,821,744	6.80	22,276,364	5.34	12,103,730	118.98	a 3,545,380	a 13.73
Northern	1,784,692	.47	1,534,967	.37	1,463,506	2,047.98	a 249,725	a 13.99
Rocky Mountain	25,158,772	6.63	28,857,413	6.92	25,211,133	691.42	3,698,641	14.70
Pacific coast	3,735,375	.98	3,991,596	.96	3,137,288	367.23	256,221	6.86

a Decrease.

RANK OF COAL-PRODUCING STATES.

In the following table the States are arranged according to their rank as coal producers, first, in the quantity of coal mined, and, second, in the value of the product. The first six States maintained the same position in 1910 that they held in 1909, except that in value of output West Virginia in 1910 exceeded Illinois and Indiana exceeded Alabama, whereas in 1909 in value of production Illinois exceeded West Virginia and Alabama exceeded Indiana. Kentucky superseded Colorado in seventh place, and Kansas, because of the decrease in production due to the strike, fell from tenth to fourteenth place. If the production of either anthracite or bituminous coal alone in Pennsylvania were considered, that State would still remain well at the head of the coal-producing States. The production of anthracite in Pennsylvania exceeded by more than one-third the total production of West Virginia, which ranked second, and Pennsylvania's bituminous production was nearly two and one-half times that of West Virginia. In the combined production of anthracite and bituminous coal Pennsylvania produced 46.8 per cent in quantity and 49.8 per cent in value of the total output of the United States. Pennsylvania's coal production exceeds that of any other country in the world with the exception of Great Britain and Germany, and in 1910 the production of Germany exceeded that of Pennsylvania by only 10,000,000 tons. In 1909 West Virginia supplanted Illinois as second among the coal-producing States. Once before, in 1906, when mining in Illinois was seriously interrupted by labor troubles, West Virginia occupied second place. In 1910 Illinois was the center of the most protracted and bitterly contested strike in the history of bituminous coal mining, and the production of the State decreased 5,000,000 tons. The operators in West Virginia, as well as in other competitive States, took advantage of the idleness in Illinois and seized upon the markets tributary to that State. West Virginia's production increased nearly 10,000,000 tons, and that State has been to all appearances firmly established as the second coal-producing State. It is noted, however, that although the production of West Virginia in 1910 exceeded that of Illinois by over 15,000,000 tons the value of the West Virginia product was only $4,260,000 more than that of the Illinois product.

With one exception the 10 leading States maintained their relative positions in 1910 in quantity and in value of the product, the exception being in the positions of Kentucky and Colorado, the former leading in production and the latter in value.

Rank of coal-producing States in 1909 and 1910, with quantity and value of product and percentage of each.

1909.

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	81,070,359	17.6		Anthracite	$149,181,587	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	460,814,616	100.0		Total	554,668,364	100.0

Rank of coal-producing States in 1909 and 1910, with quantity and value of product and percentage of each—Continued.

1910.

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	84,485,236	16.8		Anthracite	$160,275,302	25.5
	Bituminous	150,521,526	30.0		Bituminous	153,029,510	24.3
2	West Virginia	61,671,019	12.3	2	West Virginia	56,665,061	9.0
3	Illinois	45,900,246	9.1	3	Illinois	52,405,897	8.3
4	Ohio	34,209,668	6.8	4	Ohio	35,932,288	5.7
5	Indiana	18,389,815	3.7	5	Indiana	20,813,659	3.3
6	Alabama	16,111,462	3.2	6	Alabama	20,236,853	3.2
7	Kentucky	14,623,319	2.9	7	Colorado	17,026,934	2.7
8	Colorado	11,973,736	2.4	8	Kentucky	14,405,887	2.3
9	Iowa	7,928,120	1.6	9	Iowa	13,903,913	2.2
10	Wyoming	7,533,088	1.5	10	Wyoming	11,706,187	1.9
11	Tennessee	7,121,380	1.4	11	Washington	9,764,465	1.5
12	Virginia	6,507,997	1.3	12	Tennessee	7,925,350	1.3
13	Maryland	5,217,125	1.0	13	Kansas	7,914,709	1.3
14	Kansas	4,921,451	1.0	14	Virginia	5,877,486	.9
15	Washington	3,911,899	.8	15	Oklahoma	5,867,947	.9
16	New Mexico	3,508,321	.7	16	Maryland	5,835,058	.9
17	Missouri	2,982,433	.6	17	Montana	5,329,322	.8
18	Montana	2,920,970	.6	18	Missouri	5,328,285	.8
19	Oklahoma	2,646,226	.5	19	New Mexico	4,877,151	.8
20	Utah	2,517,809	.5	20	Utah	4,224,556	.7
21	Arkansas	1,905,958	.4	21	Texas	3,160,965	.5
22	Texas	1,892,176	.4	22	Arkansas	2,979,213	.5
23	Michigan	1,534,967	.3	23	Michigan	2,930,771	.5
24	North Dakota	399,041	.1	24	North Dakota	595,139	.1
25	Georgia	177,245		25	Georgia	259,122	
26	Oregon	67,533		26	Oregon	235,229	
27	California and Alaska	12,164	.1	27	California and Alaska	33,336	.1
28	Idaho	4,448		28	Idaho	17,426	
	Total	501,596,378	100.0		Total	629,557,021	100.0

PRODUCTION BY CLASSES OF MINES.

In the following tables the production of coal in the United States in 1909 and 1910 has been distributed according to the importance of the producing mines. The mines have been divided into five classes: First, mines producing 200,000 short tons or more during the year; second, mines producing from 100,000 to 200,000 short tons; third, mines producing between 50,000 and 100,000 short tons; fourth, mines producing between 10,000 and 50,000 tons; and fifth, mines producing less than 10,000 tons. In this compilation no account is taken of the small mines operated for purely local trade, nor of the anthracite recovered from old culm banks or river beds. Some producers in making their reports to the Survey combine the production of two or more mines on one schedule; in such cases the production of each mine has been assumed to be the average of all of the mines covered by the schedule.

These tables present some interesting comparisons and differences. In the combined production of bituminous coal and anthracite in 1909 less than 12 per cent of the total number of mines was in the first class, but these contributed practically 50 per cent of the total output. Mines of the first and second class together made up 24.5

per cent of the total number of mines and produced nearly 75 per cent of the total production. The tables show that the production in the anthracite region of Pennsylvania is conducted in much greater proportion by large units than is done in the bituminous fields. In the anthracite region, 56 per cent of the mines in 1909 produced over 200,000 tons each; the average from each of 170 of such mines was 386,688 short tons, and nearly 86 per cent of the total output was from mines producing over 200,000 tons each. There were 157 first-class mines in the anthracite region in 1910; they constituted 51 per cent of the total number and yielded 82.5 per cent of the total output. In the bituminous region the mines of the first class in 1909 made up only 9.3 per cent of the total number but they produced 42.5 per cent of the total output. In 1910 the bituminous mines of the first class made 10.6 per cent of the total number and they produced 46 per cent of the total output. Eighty per cent of the anthracite mines in both 1909 and 1910 were included among the first three classes; that is, mines producing more than 50,000 tons each, and this 80 per cent of mines contributed 99 per cent of the total production. In the bituminous mines there were 37.8 per cent of the total number in 1909 and 40.2 per cent in 1910 that produced over 50,000 tons, and these produced 87.4 per cent of the total output in 1909 and 88.2 per cent of the total in 1910.

Among the bituminous-producing States and Territories New Mexico leads in the proportion of tonnage by the larger units in 1909. Eighty-nine per cent of New Mexico's total production in 1909 and 88 per cent in 1910 were from mines of the first class. Nine mines out of 30 in 1909 and 9 mines out of 31 in 1910 produced over 200,000 tons. Utah ranks second in the proportion of production by large units and, in 1909, was second in the average output from the large mines. In 1910 Maryland was credited with the largest average output from mines of the first class, with 583,044 tons as the average for 4 such mines, while the production from 4 first-class mines in Montana averaged 476,812 tons each, and the average output from the 5 first-class mines in Utah was 403,876 tons. In 1909, 71.5 per cent of Utah's production was from the mines of the first class, and the average production from each mine was 405,092 short tons; in 1910, 77 per cent of Utah's production was from first-class mines and the average production was 387,350 short tons. It is to be noted, however, that there were only 4 mines in 1909 and 5 mines in 1910 in Utah that were in the first class. A little over 55 per cent of the production in each of 3 other Western States, namely, Montana, Wyoming, and Washington, was from mines which produced over 200,000 tons in 1909. In 1910, 65.4 per cent of Montana's production, 59.7 per cent of Washington's, and 60.4 per cent of Wyoming's were from mines of the first class.

Among the States east of Mississippi River there are only 3 in which more than half of the production was from mines in the first class in 1909; these were Illinois, Pennsylvania, and Virginia. In 1910 Pennsylvania was the only State east of the Mississippi in which more than half of the production was from mines of the first class. West Virginia, the second State in coal-producing importance, presents a peculiar case in that only 23.5 per cent of its total production in 1909 and 35.4 per cent in 1910 were from mines of the first class, but 37 per cent of its total production in 1909 and 30.6 per cent in 1910 were from mines of the second class. The fourth and fifth class mines in both 1909 and 1910 represented 60 per cent of the total number of mines and contributed a little over 10 per cent of the total production.

The influence of the strike in Illinois in 1910 is shown by the decrease from 97 to 58 in the number of mines producing over 200,000 tons, and the percentage of the total output from these mines decreased from 60 per cent to 44 per cent. The second-class mines in Illinois increased from 80 in 1909 to 102 in 1910, and the percentage of the total production from this class increased from 22.1 to 31.4 per cent. Kansas and Arkansas each had 3 first-class mines in 1909 and none in 1910; Missouri had 2 in 1909 and none in 1910; whereas Kentucky, which benefited from the strike in the other States, showed an increase from 3 to 9 in the number of first-class mines and from 7 to 16 in the percentage of the product from such mines.

Production of coal in the United States in 1909 and 1910 according to classes of mines, in short tons.

1909.

State.	First class.					Second class.					Third class.				
	Mines.		Production.			Mines.		Production.			Mines.		Production.		
	Number.	Percentage.	Total.	Average per mine.	Percentage.	Number.	Percentage.	Total.	Average per mine.	Percentage.	Number.	Percentage.	Total.	Average per mine.	Percentage.
Alabama	19	9.6	5,464,341	287,597	39.9	28	14.1	3,989,260	142,474	29.1	33	16.7	2,290,382	69,406	16.7
Arkansas	2	3.0	457,709	228,855	19.3	6	9.1	799,084	133,181	33.6	8	12.1	579,404	73,676	24.4
California															
Colorado	11	7.7	3,489,835	317,258	32.6	26	18.2	3,904,493	150,173	36.5	24	16.8	1,802,091	75,087	16.8
Georgia						1	50.0	185,196	185,196	87.7					
Idaho															
Illinois	97	15.7	30,544,228	314,889	60.1	80	12.9	11,248,649	140,608	22.1	68	10.9	5,059,648	74,407	10.0
Indiana	15	5.1	3,958,396	263,893	26.8	36	12.2	5,607,829	155,773	37.9	48	16.2	3,636,446	75,759	24.6
Iowa	3	1.0	674,279	224,760	8.7	25	8.1	3,198,824	127,953	41.4	23	7.4	1,724,852	74,994	22.3
Kansas	3	1.5	661,264	220,421	9.5	20	10.3	2,524,688	126,234	36.2	30	15.5	2,254,927	75,164	32.4
Kentucky	3	1.0	745,339	248,446	7.0	23	8.0	3,394,174	147,573	32.1	45	15.7	3,061,836	68,041	28.9
Maryland						14	20.6	a 2,353,849	168,132	58.8	11	16.2	860,038	78,185	21.4
Michigan						5	15.6	711,920	142,384	39.9	12	37.5	859,719	71,643	48.2
Missouri	2	.9	423,003	211,502	11.6	7	3.1	811,820	115,974	22.4	13	5.8	871,176	67,014	24.0
Montana	6	10.0	1,406,158	267,693	55.2	3	5.0	510,433	170,144	20.0	1	1.7	97,210	97,210	3.8
New Mexico	9	30.0	2,487,203	276,356	88.9						1	3.3	99,691	99,691	3.6
North Dakota						1	1.7	115,340	115,340	28.8	1	1.7	52,000	52,000	13.0
Ohio	31	5.6	8,487,443	273,788	30.7	66	12.0	9,118,800	138,164	32.9	64	11.6	5,233,471	81,733	18.9
Oklahoma											32	32.3	b 2,128,245	66,508	68.4
Oregon															
Pennsylvania, bituminous	251	16.8	78,155,290	311,336	56.7	220	14.7	31,535,512	143,343	22.9	210	14.1	15,202,496	72,393	11.0
Tennessee	6	4.5	1,571,246	261,874	24.7	11	8.3	1,439,853	130,896	22.7	30	22.7	1,879,529	62,651	29.6
Texas						6	14.3	a 746,547	124,424	40.9	6	14.3	424,337	70,723	23.3
Utah	4	17.4	1,620,370	405,092	71.5	4	17.4	490,231	122,558	21.6	1	4.4	60,794	60,794	2.7
Virginia	8	12.9	3,005,165	375,646	63.3	3	4.8	470,672	156,891	9.8	8	12.9	564,928	70,616	11.9
Washington	8	17.4	2,076,630	259,579	57.7	4	8.7	594,598	148,650	16.5	5	10.9	401,353	80,271	11.1
West Virginia	48	7.2	12,160,494	253,342	23.5	132	19.9	19,059,922	144,393	36.8	231	34.8	15,723,726	68,068	30.3
Wyoming	13	21.3	3,541,369	272,413	55.5	10	16.4	1,640,056	164,006	25.7	10	16.4	821,695	82,169	12.9
Total bituminous	539	9.3	160,929,762	300,426	42.5	731	12.7	104,451,750	142,889	27.6	915	15.8	65,689,994	71,792	17.3
Pennsylvania, anthracite	170	55.9	65,736,966	386,688	85.6	50	16.4	8,226,848	164,537	10.7	25	8.2	1,955,821	78,233	2.5
Grand total	709	11.7	226,666,728	319,699	49.8	781	12.8	112,678,598	144,275	24.7	940	15.5	67,645,815	71,963	14.8

State.	Fourth class. Mines. Number.	Fourth class. Mines. Percentage.	Fourth class. Production. Total.	Fourth class. Production. Average per mine.	Fourth class. Production. Percentage.	Fifth class. Mines. Number.	Fifth class. Mines. Percentage.	Fifth class. Production. Total.	Fifth class. Production. Average per mine.	Fifth class. Production. Percentage.	Total. Mines.	Total. Quantity.	Total. Average per mine.
Alabama	64	32.3	1,715,558	26,806	12.5	54	27.3	243,449	4,508	1.8	198	13,702,990	69,207
Arkansas	20	30.3	427,867	21,393	18.0	30	45.5	111,150	3,705	4.7	66	2,375,214	35,988
California	1	20.0	35,763	35,763	78.3	4	80.0	9,872	2,468	21.7	5	45,635	9,109
Colorado	44	30.8	1,357,019	30,841	12.7	38	26.5	145,458	3,828	1.4	143	10,698,896	74,817
Georgia	1	50.0	26,000	26,000	12.3						2	211,196	105,598
Idaho						2	100.0	4,553	2,777	100.0	2	4,553	2,777
Illinois	112	18.1	3,038,725	27,131	6.0	263	42.4	901,759	3,429	1.8	620	50,793,009	81,924
Indiana	44	14.8	1,137,169	25,845	7.7	153	51.7	441,650	2,887	3.0	296	14,781,490	49,937
Iowa	68	22.0	1,637,963	24,088	21.2	190	61.5	490,831	2,583	6.4	309	7,726,749	25,006
Kansas	48	24.7	1,233,203	25,692	17.7	93	47.9	289,710	3,115	4.2	194	6,963,792	35,896
Kentucky	104	36.2	3,003,371	28,879	28.3	112	39.0	386,670	3,452	3.7	287	10,591,390	36,904
Maryland	24	35.3	738,284	30,762	18.4	19	27.9	53,743	2,829	1.4	68	4,005,914	58,910
Michigan	7	21.9	180,833	25,832	10.1	8	25.0	30,840	3,605	1.8	32	1,783,312	55,728
Missouri	49	21.9	1,015,697	20,729	28.0	153	68.3	505,484	3,304	14.0	224	3,627,180	16,193
Montana	15	25.0	443,680	29,579	17.4	35	58.3	88,927	2,541	3.5	60	2,546,408	42,440
New Mexico	8	26.7	178,840	22,355	6.3	12	40.0	32,816	2,735	1.2	30	2,798,550	93,285
North Dakota	6	10.4	75,392	12,565	18.8	50	86.2	157,077	3,141	39.4	58	399,809	6,893
Ohio	166	30.2	3,906,656	23,534	14.1	223	40.6	937,910	4,206	3.4	550	27,684,280	50,335
Oklahoma	29	29.3	789,497	27,224	25.3	38	38.4	195,408	5,142	6.3	99	3,113,150	31,445
Oregon	2	20.0	70,201	35,101	83.3	8	80.0	14,123	1,765	16.7	10	84,324	8,432
Pennsylvania, bituminous	427	28.6	11,496,367	26,924	8.3	384	25.7	1,420,403	3,699	1.0	1,492	137,810,068	92,366
Tennessee	52	39.4	1,335,237	25,678	21.0	33	25.0	123,710	3,749	2.0	132	6,349,575	48,102
Texas	22	52.4	615,109	27,960	33.7	8	19.0	38,447	4,806	2.1	42	1,824,440	43,439
Utah	3	13.0	78,564	26,185	3.5	11	47.8	14,358	1,305	.7	23	2,264,317	98,449
Virginia	24	38.7	632,036	26,335	13.3	19	30.7	75,588	3,988	1.6	62	4,748,389	76,584
Washington	18	39.1	481,137	26,730	13.4	11	23.9	48,495	4,409	1.3	46	3,602,213	78,396
West Virginia	168	25.3	4,544,236	27,049	8.8	85	12.8	304,335	3,580	.6	664	51,792,713	78,001
Wyoming	10	16.4	335,518	33,552	5.2	18	29.5	46,883	2,605	.7	61	6,385,521	104,681
Total bituminous	1,536	26.6	40,529,922	26,387	10.7	2,054	35.6	7,113,649	3,463	1.9	5,775	378,715,077	65,578
Pennsylvania, anthracite	29	9.5	774,172	26,695	1.0	30	10.0	119,755	3,992	.2	304	76,813,562	252,676
Grand total	1,565	25.7	41,304,094	26,392	9.1	2,084	34.3	7,233,404	3,471	1.6	6,079	455,528,639	74,918

a Includes two or possibly three mines producing over 200,000 tons but not reported separately.
b Includes mines producing more than 100,000 tons not reported separately.

Production of coal in the United States in 1909 and 1910 according to classes of mines, in short tons—Continued

1910.

State.	First class.					Second class.					Third class.				
	Mines.		Production.			Mines.		Production.			Mines.		Production.		
	Number.	Percentage.	Total.	Average per mine.	Percentage.	Number.	Percentage.	Total.	Average per mine.	Percentage.	Number.	Percentage.	Total.	Average per mine.	Percentage.
Alabama	18	8.1	4,182,595	232,366	26.0	50	22.6	6,932,110	138,642	43.0	37	16.8	2,732,495	73,851	16.9
Arkansas						5	7.9	627,493	125,499	32.9	9	14.3	612,998	68,111	32.2
California															
Colorado	18	9.4	5,425,791	301,433	45.3	20	10.5	2,508,167	125,408	20.9	31	16.2	2,425,513	78,242	20.3
Georgia						1	33.3	151,073	151,073	85.2					
Idaho															
Illinois	58	10.3	20,151,755	347,444	44.0	102	18.1	14,408,916	141,264	31.4	96	17.1	7,183,676	74,830	15.7
Indiana	29	11.6	7,576,184	261,248	41.2	46	18.3	6,858,477	149,097	37.4	34	13.6	2,529,523	74,398	13.8
Iowa	2	.7	467,959	233,980	5.9	25	9.3	3,265,393	130,616	41.4	27	10.1	1,976,610	73,208	25.0
Kansas						2	1.3	290,449	145,225	5.9	40	25.8	2,796,638	69,919	57.3
Kentucky	9	3.1	2,327,162	258,573	16.0	42	14.5	5,739,041	136,644	39.5	52	17.9	3,514,406	67,585	24.2
Maryland	4	5.5	2,332,174	583,044	44.8	6	8.2	926,818	154,470	17.8	12	16.4	961,393	80,116	18.5
Michigan						6	18.8	667,677	111,280	43.5	9	28.1	645,336	71,704	42.1
Missouri						3	1.4	363,438	121,146	12.7	15	7.2	1,099,818	73,321	38.3
Montana	4	7.0	1,907,248	476,812	65.4	3	5.3	444,449	148,150	15.2	1	1.8	61,352	61,352	2.1
New Mexico	9	29.1	3,087,521	343,058	88.2	1	3.2	144,344	144,344	4.1	1	3.2	73,106	73,106	2.1
North Dakota						1	2.3	136,197	136,197	36.7					
Ohio	50	7.2	14,962,570	299,251	44.0	68	9.9	10,148,608	149,244	29.8	57	8.3	3,882,830	68,120	11.4
Oklahoma						2	2.0	200,966	100,483	7.6	17	17.4	1,136,433	66,849	43.1
Oregon															
Pennsylvania bituminous	289	19.6	93,458,444	323,386	62.1	190	12.9	27,085,391	142,556	18.0	254	17.2	18,405,748	72,464	12.2
Tennessee	7	5.4	1,967,408	281,058	27.6	12	9.3	1,662,322	138,527	23.4	27	20.9	1,832,580	67,873	25.7
Texas	1	2.3	223,481	223,481	11.8	2	4.6	253,628	126,814	13.4	10	23.3	731,698	73,170	38.7
Utah	5	22.7	1,936,750	387,350	77.0	3	13.6	365,881	121,960	14.5	2	9.1	121,204	60,602	4.8
Virginia	7	11.1	2,827,133	403,876	43.4	13	20.6	2,140,050	164,619	32.9	14	22.2	916,560	65,469	14.1
Washington	9	18.8	2,333,342	259,260	59.7	5	10.4	527,262	105,452	13.5	11	22.9	720,552	65,505	18.4
West Virginia	83	11.6	21,806,147	262,725	35.4	139	19.4	18,866,228	135,728	30.6	197	27.5	14,094,862	71,548	22.9
Wyoming	16	24.2	4,545,011	284,063	60.4	16	24.2	2,337,675	146,106	31.0	7	10.6	402,942	57,563	5.4
Total bituminous	618	10.6	191,518,675	309,901	46.0	763	13.1	107,052,053	140,304	25.7	960	16.5	68,858,273	71,727	16.5
Pennsylvania anthracite	157	51.0	65,788,484	419,035	82.5	64	20.8	10,664,819	166,638	13.4	26	8.4	2,281,971	87,768	2.9
Grand total	775	12.7	257,307,159	332,009	51.9	827	13.5	117,716,872	142,342	23.7	986	16.1	71,140,244	72,150	14.3

State.	Fourth class.					Fifth class.					Total.		
	Mines.		Production.			Mines.		Production.					
	Number.	Percentage.	Total.	Average per mine.	Percentage.	Number.	Percentage.	Total.	Average per mine.	Percentage.	Mines.	Quantity.	Average per mine.
Alabama	77	34.8	2,089,845	27,141	13.0	39	17.7	174,107	4,464	1.1	221	16,111,152	72,901
Arkansas	21	33.3	545,989	25,999	28.7	28	44.5	119,058	4,252	6.2	63	1,905,538	30,247
California	......	......	......	......	......	4	100.0	11,164	2,791	100.0	4	11,164	2,791
Colorado	54	28.3	1,468,896	27,202	12.3	68	35.6	140,671	2,069	1.2	191	11,969,038	62,665
Georgia	1	33.3	25,000	25,000	14.1	1	33.3	1,172	1,172	.7	3	177,245	59,082
Idaho	......	......	......	......	......	3	100.0	4,448	1,483	100.0	3	4,448	1,483
Illinois	129	23.0	3,378,019	26,186	7.4	177	31.5	696,311	3,934	1.5	562	45,818,677	81,528
Indiana	38	15.1	1,063,026	27,974	5.8	104	41.4	324,514	3,120	1.8	251	18,351,724	73,114
Iowa	76	28.4	1,847,480	24,309	23.4	138	51.5	336,268	2,437	4.3	268	7,893,710	29,454
Kansas	54	34.8	1,523,246	28,208	31.2	59	38.1	272,847	4,625	5.6	155	4,883,180	31,504
Kentucky	91	31.4	2,580,920	28,362	17.7	96	33.1	373,681	3,893	2.6	290	14,535,210	50,121
Maryland	27	37.0	907,999	33,630	17.5	24	32.9	74,768	3,115	1.4	73	5,203,152	71,276
Michigan	12	37.5	213,600	17,800	13.9	5	15.6	7,168	1,434	.5	32	1,533,781	47,931
Missouri	38	18.3	810,253	21,322	28.2	152	73.1	595,418	3,917	20.8	208	2,868,927	13,793
Montana	17	29.8	410,288	24,135	14.1	32	56.1	94,136	2,942	3.2	57	2,917,473	51,184
New Mexico	8	25.8	162,029	20,254	4.6	12	38.7	33,335	2,778	1.0	31	3,500,335	112,914
North Dakota	7	15.9	158,895	22,699	42.8	36	81.8	76,361	2,121	20.5	44	371,453	8,442
Ohio	167	24.2	3,984,206	23,858	11.7	348	50.4	1,039,496	2,987	3.1	690	34,017,710	49,301
Oklahoma	46	46.9	1,153,991	25,087	43.7	33	33.7	148,824	4,510	5.6	98	2,640,214	26,941
Oregon	2	18.2	51,119	25,560	76.3	9	81.8	15,880	1,764	23.7	11	66,999	6,091
Pennsylvania bituminous	367	24.8	9,990,563	27,222	6.7	376	25.5	1,469,688	3,909	1.0	1,476	150,409,834	101,904
Tennessee	53	41.1	1,552,378	29,290	21.8	30	23.3	105,154	3,505	1.5	129	7,119,842	55,193
Texas	26	60.5	675,620	25,985	35.7	4	9.3	7,749	1,937	.4	43	1,892,176	44,004
Utah	2	9.1	64,530	32,265	2.6	10	45.5	27,234	2,723	1.1	22	2,515,599	114,345
Virginia	20	31.8	583,268	29,163	9.0	9	14.3	38,289	4,254	.6	63	6,505,300	103,259
Washington	11	22.9	291,184	26,471	7.4	12	25.0	39,559	3,297	1.0	48	3,911,899	81,498
West Virginia	218	30.5	6,551,193	30,051	10.6	79	11.0	287,188	3,635	.5	716	61,605,618	86,041
Wyoming	6	9.1	198,484	33,081	2.6	21	31.9	46,747	2,226	.6	66	7,530,859	114,104
Total bituminous	1,568	27.0	42,282,021	26,966	10.2	1,909	32.8	6,561,235	3,437	1.6	5,818	416,272,257	71,549
Pennsylvania anthracite	28	9.1	812,517	29,018	1.0	33	10.7	147,808	4,479	.2	308	79,695,599	258,752
Grand total	1,596	26.0	43,094,538	27,002	8.7	1,942	21.7	6,709,043	3,458	1.4	6,126	495,967,856	80,961

LABOR STATISTICS.

The number of men employed in the coal mines of the United States and the average number of days worked for the years 1905, 1906, 1907, 1908, and 1910 are shown, by States, in the following table. The statistics of labor in 1909 were collected on the general schedules of the Census Office, and the inquiries were prepared in such a manner that the compilations do not give results comparable with the statistics as presented in these reports; nor are the final figures of the census for 1909 available at the time of writing this report.

According to the returns to the Survey there were 725,030 men employed in the coal mines of the United States in 1910 as compared with 690,438 in 1908 and 680,492 in 1907. Of the total number of employees, 555,533 were bituminous mine workers and 169,497 were employed in the anthracite mines of Pennsylvania.

Notwithstanding the time lost by the strike in the Illinois and southwestern fields, the average time made in the bituminous mines was 217 working days, the average time in the anthracite mines, 229 days, and the general average for all mines, 220 days. The employees in the anthracite mines made the largest number of days in 20 years, and in spite of the idleness of from two to six months in the Middle Western States the average time made by bituminous workers was better than in any year since 1903, with the exception of the boom year of 1907.

The average production for each man employed was 498 short tons in the anthracite region and 751 tons in the bituminous mines. The average daily production for each man employed was 2.17 tons in the anthracite mines and 3.46 tons in the bituminous mines.

Statistics of labor employed in coal mines of the United States, 1905-1910, by States.

State or Territory.	1905		1906		1907		1908		1910	
	Number of days active.	Average number employed.	Number of days active.	Average number employed.	Number of days active.	Average number employed.	Number of days active.	Average number employed.	Number of days active.	Average number employed.
Alabama	225	19,595	237	20,555	242	21,388	222	19,197	249	22,210
Arkansas	177	4,192	165	4,298	190	5,085	145	5,337	128	5,568
California	a 294	a 144	a 253	a 56	a 187	a 76	a 220	a 49	189	19
Colorado	255	11,020	268	11,368	258	14,223	212	14,523	236	15,864
Georgia	b 266	b 816	279	737	262	808	261	670	265	386
Idaho	c 107	c 37	c 157	c 25	d 121	d 22	160	24	200	14
Illinois	201	58,053	192	61,988	218	65,581	185	68,035	160	72,645
Indiana	151	25,323	175	20,970	197	21,022	174	18,380	229	21,878
Iowa	209	15,113	224	15,260	230	15,585	214	16,021	218	16,666
Kansas	212	11,926	165	14,355	225	12,439	181	13,916	148	12,870
Kentucky	200	14,685	212	15,272	210	16,971	186	16,996	221	20,316
Maryland	252	5,948	250	6,438	263	5,880	220	6,079	270	5,809
Michigan	186	3,696	173	3,971	234	3,982	207	4,247	211	3,575
Missouri	194	8,962	185	9,557	214	8,448	169	8,988	154	9,691
Montana	243	2,181	243	2,394	268	2,735	224	3,146	239	3,837
New Mexico	234	2,108	242	2,070	269	2,970	197	3,448	283	3,585
North Dakota	187	626	209	488	223	562	181	631	207	534
Ohio	176	43,399	167	45,438	199	46,833	161	47,407	203	46,641
Oklahoma (Indian Territory)	188	7,712	166	8,251	216	8,398	172	8,651	144	8,657
Oregon	242	316	224	209	231	184	249	214	257	153
Pennsylvania bituminous	231	143,629	231	152,099	255	163,295	201	165,961	238	175,403
Tennessee	222	11,928	229	11,452	232	12,052	209	11,812	225	11,930
Texas	238	3,008	227	3,048	242	4,227	254	4,400	234	4,197
Utah	247	1,361	288	1,572	258	2,203	227	2,664	260	3,053
Virginia	241	5,730	250	5,131	241	6,670	200	6,208	241	7,264
Washington	227	4,765	266	4,529	273	5,945	202	5,484	256	6,314
West Virginia	209	48,389	220	50,960	230	59,029	185	56,861	228	68,663
Wyoming	236	5,977	281	5,934	275	6,645	217	6,915	248	7,771
Total bituminous	211	460,629	213	478,425	234	513,258	193	516,264	217	555,533
Pennsylvania anthracite	215	165,406	195	162,355	220	167,234	200	174,174	229	169,497
Grand total	212	626,035	209	640,780	231	680,492	195	690,438	220	725,030

a Includes Alaska. b Includes North Carolina. c Includes Nevada. d Includes Nebraska and Nevada.

In the following table is presented a statement of the number of men employed in the anthracite and bituminous mines, the average number of days worked, and the average production per man per day and per year, annually since 1890, except for 1909. The statistics of labor employed in 1909 were collected on the general schedules of the Bureau of the Census and have not been compiled in a manner that permits comparisons with other years as compiled by the survey. It will be noted that in the 20 years covered by this table there has been a marked increase in both the daily and the yearly output per man in the bituminous mines, due principally to the increased use of machinery for mining the coal. In 1891, the first year for which the statistics of machine-mined coal were collected, this factor represented only a little more than 5 per cent of the total output, and the average production per man was 2.56 short tons for each working day and 579 tons for the year; in 1910 41.7 per cent of the total bituminous product was mined by machines and the average production for each employee was 3.46 tons for each working day and 751 tons for the year. In only one year, 1907, has the yearly production per man exceeded the record for 1910, and the daily output per man in 1910 was the best ever made.

The average production per man in the anthracite mines in 1890 was 369 short tons and the average daily tonnage per man was 1.85 tons. There was a generally increasing tendency in the productive efficiency per man per day up to 1899, when the maximum of 2.5 tons per man per day was attained. Since 1899 this production has varied considerably. The maximum yearly production per man in the anthracite as in the bituminous fields was made in 1907, when the average was 512 tons. The average daily production of 2.17 tons in 1910 was the smallest in 15 years.

Production of coal according to number of persons employed, 1890–1910.

Years.	Anthracite.				Bituminous.			
	Men employed.	Days worked.	Average tonnage per man per day.	Average tonnage per man per year.	Men employed.	Days worked.	Average tonnage per man per day.	Average tonnage per man per year.
1890	126,000	200	1.85	369	192,204	226	2.56	579
1891	126,350	203	1.98	401	205,803	223	2.57	573
1892	129,050	198	2.06	407	212,893	219	2.72	596
1893	132,944	197	2.06	406	230,365	204	2.73	557
1894	131,603	190	2.08	395	244,603	171	2.84	486
1895	142,917	196	2.07	406	239,962	194	2.90	563
1896	148,991	174	2.10	365	244,171	192	2.94	564
1897	149,884	150	2.34	351	247,817	196	3.04	596
1898	145,504	152	2.41	367	255,717	211	3.09	651
1899	139,608	173	2.50	433	271,027	234	3.05	713
1900	144,206	166	2.40	398	304,375	234	2.98	697
1901	145,309	196	2.37	464	340,235	225	2.94	664
1902	148,141	116	2.40	279	370,056	230	3.06	703
1903	150,483	206	2.41	496	415,777	225	3.02	680
1904	155,861	200	2.35	469	437,832	202	3.15	637
1905	165,406	215	2.18	470	460,629	211	3.24	684
1906	162,355	195	2.25	439	478,425	213	3.36	717
1907	167,234	220	2.33	512	513,258	234	3.29	769
1908	174,174	200	2.39	478	516,264	193	3.34	644
1910	169,497	229	2.17	498	555,533	217	3.46	751

In most of the bituminous coal producing regions of the United States the mines are operated 8 hours a day. In 1910, out of a total of 555,533 men employed, 327,986 worked in mines that were operated on the 8-hour basis, 59,756 worked in mines that were operated 9 hours a day, and 140,627 worked in mines that were operated 10 hours a day. There were 26,745 men employed in mines that did not report the number of hours to the working day. It must be remembered, however, that when the length of the working day is stated reference is made to the time the mines are supposed to be in operation, not to the number of hours worked by the miners. In both the anthracite and the bituminous fields practically all of the coal is mined by contract at so much per ton, per mine car, by yardage, or on other basis of payment, and the miner being an independent contractor is not obliged to put in a certain number of hours at his working place. Since the settlement of the great strike of 1902 the anthracite mines of Pennsylvania have been operated on a 9-hour basis, with the exception of engineers and pumpmen, who work 8 hours, and, of course, the miners who work by contract. In the bituminous fields the 8-hour day prevails in the States where the men are well organized, and in the districts where the mines are "open shop" or nonunion the 9 or 10 hour day is usual. The important bituminous coal-producing States in which the 8-hour day is generally observed are Arkansas, Illinois, Indiana, Iowa, Kansas, Michigan, Missouri, Montana, Ohio, Oklahoma, Pennsylvania, Texas, Utah, Washington, and Wyoming. In two of the Rocky Mountain States—Colorado and New Mexico—and in the Southern States—Alabama, Kentucky, Maryland, Tennessee, Virginia, and West Virginia—the longer day of 9 or 10 hours is the common practice.

Number of hours to the working day, by States and Territories.

1908.

State or Territory.	8 hours.		9 hours.		10 hours.		All others.
	Mines.	Men.	Mines.	Men.	Mines.	Men.	Men.
Alabama	16	1,205	34	2,358	100	11,969	3,665
Arkansas	67	5,325					12
Colorado	79	5,158	3	63	61	8,535	767
Illinois	491	65,289	5	510			2,236
Indiana	207	18,040			1	5	335
Iowa	218	14,772	3	28	4	24	1,197
Kansas	138	12,973	11	283	7	363	297
Kentucky	56	4,636	52	2,072	132	9,166	1,122
Maryland	1	80	3	59	49	5,905	35
Michigan	31	4,224					23
Missouri	149	8,464	10	83			441
Montana	36	2,903	1	2			241
New Mexico	5	30	6	356	14	3,015	47
North Dakota	11	103	5	114	14	275	139
Ohio	510	45,742	8	1,004	3	35	626
Oklahoma	64	8,258			4	118	275
Oregon	2	69					145
Pennsylvania	764	99,406	241	24,828	197	38,125	3,602
Tennessee	5	287	87	8,220	19	1,921	1,384
Texas	16	2,351	1	50	21	1,759	240
Utah	17	2,620			1	2	42
Virginia	2	112	10	802	32	5,214	80
Washington	39	4,665	1	20			799
West Virginia	30	1,242	180	14,426	403	39,550	1,643
Wyoming	51	6,802			2	17	96
Total	3,005	314,756	661	55,278	1,064	125,998	19,489

Number of hours to the working day, by States and Territories—Continued.

1910.

State or Territory.	8 hours.		9 hours.		10 hours.		All others.
	Mines.	Men.	Mines.	Men.	Mines.	Men.	Men.
Alabama	18	766	36	2,633	134	17,306	1,505
Arkansas	63	5,312					256
Colorado	61	2,935	8	303	49	5,913	6,713
Illinois	521	69,575	7	137	1	4	2,929
Indiana	215	20,783	4	16	3	14	1,065
Iowa	229	16,238	2	10	3	11	407
Kansas	126	12,255	9	115	1	5	495
Kentucky	69	6,095	56	3,965	126	9,064	1,192
Maryland	3	9	6	71	61	5,717	12
Michigan	27	3,511					64
Missouri	166	9,027	10	100	1	17	547
Montana	44	3,568			1	6	263
New Mexico	5	21	5	185	16	3,345	34
North Dakota	11	94	6	75	16	327	38
Ohio	587	45,001	12	249	1	5	1,386
Oklahoma	89	8,472			2	50	135
Oregon	6	150			1	1	2
Pennsylvania	834	101,208	272	30,270	225	37,769	6,156
Tennessee	5	451	86	7,566	32	3,395	518
Texas	20	2,302	1	70	17	1,536	289
Utah	20	3,049					4
Virginia	1	189	10	1,021	45	5,710	344
Washington	40	6,129					185
West Virginia	49	4,671	133	12,950	494	50,432	610
Wyoming	41	6,175					1,596
Total	3,250	327,986	663	59,756	1,229	140,627	26,745

There are so many influences affecting the production of coal in the several States that it is not possible to draw any reliable conclusions in regard to the effect of the length of the working day upon the productive efficiency of the labor. Principal among these is the independent character of the miner himself, for whom no time record is kept. The thickness of the coal beds and the character of the coal are potential influences upon the capacity of the miner, and these vary over such wide ranges even in one State that any deductions drawn from the statistics herewith presented would be misleading and valueless. In New Mexico, for instance, where the 10-hour day prevails, the largest production per man, 979 tons, was made in 1910, while in Wyoming, where the mines are operated 8 hours a day, the second best record, of 969 tons, was made. On the other hand, the smallest records for 1910, of 306, 308, and 342 tons, were made in Oklahoma, Missouri, and Arkansas, respectively, in which States the mines are operated 8 hours; but in all three of these States mining conditions are unfavorable. West Virginia, a 9-hour and 10-hour State, had the best daily record, of 3.94 tons per man, in 1910, followed closely by Wyoming, an 8-hour State, with 3.91 tons per day per man.

The following table shows the average production per man per day and per year, compared with the average number of days the mines were operated and the hours per day made at the majority of mines in the important coal-producing States in 1907, 1908, and 1910:

Average production per man compared with hours worked per day, and average number of days per year in 1907, 1908, and 1910.

State or Territory.	1907				1908				1910			
	Number of hours per day.	Days worked.	Average tonnage.		Number of hours per day.	Days worked.	Average tonnage.		Number of hours per day.	Days worked.	Average tonnage.	
			Per year.	Per day.			Per year.	Per day.			Per year.	Per day.
Alabama	9 and 10	242	666.3	2.75	9 and 10	222	604.5	2.72	9 and 10	249	725	2.91
Arkansas	8	190	525.2	2.76	8	145	389.4	2.68	8	128	342	2.67
Colorado	8 and 10	258	758.6	2.94	8 and 10	212	663.4	3.13	8 and 10	236	755	3.20
Illinois	8	218	782.5	3.59	8	185	700.5	3.79	8	160	632	3.95
Indiana	8	197	665.3	3.38	8	174	670.0	3.85	8	229	841	3.67
Iowa	8	230	486.0	2.11	8	214	447.0	2.09	8	218	476	2.18
Kansas	8	225	588.7	2.62	8	181	448.8	2.48	8	148	382	2.58
Kentucky	8, 9, and 10	210	633.[illegible]	3.02	8, 9, and 10	186	602.9	3.24	8, 9, and 10	221	720	3.26
Maryland	10	263	940.9	3.58	10	220	720.0	3.27	10	270	898	3.33
Michigan	8	234	511.3	2.19	8	207	432.1	2.09	8	211	429	2.03
Missouri	8	214	473.[illegible]	2.21	8	169	369.1	2.18	8	154	308	2.00
Montana	8	268	737.4	2.75	8	224	610.4	2.73	8	239	762	3.19
New Mexico	10	269	885.2	3.29	10	197	715.8	3.63	10	283	979	3.46
Ohio	8	199	686.3	3.45	8	161	554.2	3.44	8	203	733	3.61
Oklahoma (Indian Territory)	8	216	433.8	2.01	8	172	340.8	1.98	8	144	306	2.13
Pennsylvania:												
Anthracite	9	220	511.9	2.33	9	200	478.1	2.39	9	229	498	2.17
Bituminous	a 8	255	919.5	3.61	a 8	201	706.1	3.51	a 8	238	858	3.61
Tennessee	9 and 10	232	565.1	2.44	9 and 10	209	524.8	2.51	9 and 10	225	597	2.65
Utah	8	258	884.1	3.43	8	227	693.2	3.05	8	260	825	3.17
Virginia	10	241	706.3	2.93	10	200	686.1	3.43	10	241	896	3.72
Washington	8	273	619.1	2.27	8	202	551.6	2.73	8	256	620	2.42
West Virginia	9 and 10	230	814.7	3.54	9 and 10	185	736.8	3.98	9 and 10	228	898	3.94
Wyoming	8	275	941.0	3.42	8	217	793.9	3.66	8	248	969	3.91

a Represents 60 per cent of employees; the other 40 per cent about evenly divided between 9 and 10 hours.

LABOR TROUBLES.

More time was lost through labor troubles in 1910 than in any year in the history of the coal-mining industry. It was the year for troubles, as it was one of the "even" years when the wage scales for the bituminous mines in the organized States are renewed and when the conflicts between miners and operators are repeated with more or less severity, but with regrettable regularity every two years. During the last 10 years the three in which the most serious interruptions to operations have occurred were 1902, 1906, and 1910, from which it appears that in every alternate "even" year the attacks are more severe. In 1902 the anthracite region of Pennsylvania was the storm center, in 1906 the trouble was general throughout the organized States, and in 1910 it was confined principally to the States of the Mississippi Valley region. Since the settlement of the strike of 1902 the anthracite region of Pennsylvania has enjoyed peace, prosperity, and contentment to a degree previously unknown. The terms upon which the strike was settled have been twice renewed voluntarily by the operators and their employees, and as each agreement was for three years, the first dating from April 1, 1903, the reign of peace continued through 1910 and will continue until March 31, 1912. In 1906 the struggle was of a peaceful character, though the total idleness was, with the exception of 1910, the longest on record. The men were not called out "on strike," but were simply requested by their leaders to suspend work until the wage scales were agreed upon, and they did. No attempt was made by the operators to break the "strike" by opening the mines with nonunion labor, and the period of idleness was remarkable for the absence of disturbances of the peace. The idleness lasted about two months and affected 372,343 men out of a total of 478,425 in the bituminous mines. In the strike of 1910 there were fewer men idle than in the "suspension" of 1906, but the aggregate time lost was slightly greater. The greatest disturbance in 1910 was in Illinois, Kansas, Missouri, Arkansas, and Oklahoma, and in less degree in Iowa, Michigan, Indiana, Colorado, and Texas. In the first five States the majority of the mines were idle from April 1 to September 15, and the strike was finally settled by the practical surrender of the operators, with a 5.55 per cent advance in wages. The operators were driven to this action, first, by the secession of two districts in Illinois from the Operator's Association and of some of the members of the Southwestern Association, and by the invasion of other coals into the markets naturally supplied by the mines affected by the strike. The operators in Indiana, Iowa, Michigan, and Texas compromised with the miners at the end of two months. In Colorado the strike lasted about three months. The strikes in other States were not of a general character. The most serious one occurred in the Irwin-Greensburg district of Pennsylvania. It began April 1, 1910, and was not officially declared off until July 1, 1911. In Ohio the Crooksville or "thin-vein Hocking" district was the scene of strike idleness for eight months. The number of men made idle by strikes in the bituminous mines in 1910 was 215,640 out of a total of 555,533. The average time lost by each man was 89 working days. The total time lost was 19,234,785 days, which, at the rate of $1.50 a day to each man, would represent nearly $30,000,000 in wages. It is recognized, however, that no such loss took place, for many of the miners migrated to other States or districts and found employment, and a large part of the lost time and wages were made up by increased activity both before and after the strike.

The statistics of labor troubles in the coal mines of the United States in 1909 and 1910 are presented in the following table:

Statistics of labor strikes in the coal mines of the United States in 1909 and 1910.

State or Territory.	1909			1910		
	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	....	....	....	25	1,250	50
Arkansas	1,443	41,836	29	4,873	713,210	146
Colorado	55	1,250	23	2,044	195,558	96
Georgia	....	....	....	270	2,970	11
Illinois	2,335	90,720	38	67,218	9,133,953	136
Indiana	36	720	20	12,638	423,894	34
Iowa	2,036	12,504	6	9,209	408,563	44
Kansas	4,715	71,566	15	10,346	1,578,027	153
Kentucky	275	16,500	60	1,475	15,197	10
Maryland	25	175	7	....	....	....
Michigan	527	23,002	44	1,663	86,789	52
Missouri	957	6,593	7	7,774	1,218,599	157
Montana	110	1,100	10	345	38,260	111
North Dakota	75	525	7	....	....	....
Ohio	2,375	139,434	59	24,746	1,334,631	54
Oklahoma	1,576	11,368	7	8,213	1,247,828	152
Pennsylvania	5,824	260,381	45	60,098	2,700,746	45
Tennessee	277	9,295	34	....	....	....
Texas	80	4,800	60	1,776	108,230	61
Washington	123	2,300	19	101	303	3
West Virginia	1,919	29,565	15	1,630	13,985	9
Wyoming	....	....	....	1,196	12,792	11
Total bituminous	24,763	723,634	29	215,640	19,234,785	89
Pennsylvania anthracite	771	8,016	10	2,853	15,739	6

A summary of the statistics of strikes in the coal mines of the United States since 1899 is given in the following table:

Summary of labor strikes in the coal mines of the United States, 1899–1910.

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
1910	218,493	19,250,524	88

[a] Bituminous mines only.

COAL MINED BY MACHINES.

In the quantity of coal mined by machines as in the total production of coal, 1910 surpassed all previous records, and of the total increase of 37,366,885 short tons of bituminous coal and lignite in

1910 over 1909, 31,515,415 tons, or over 80 per cent, was in machine-mined coal. The quantity of coal produced by machines in 1910 was 174,012,293 short tons, or 41.7 per cent of the total output of bituminous and lignite. In 1909 the machined-mined production amounted to 142,496,878 short tons, or 38 per cent of the total. The rapid progress made in recent years in the substitution of mechanical methods of mining bituminous coal for hard labor has been one of the most notable developments in the history of the industry. In many cases it is true that necessity has been the mother of invention and the installation of machinery has been compelled by the exigencies of the trade, involving high rates of labor and low prices for coal. In no branch of industry has there existed keener competition than in the bituminous coal trade. It is well known by those familiar with the industry that the present developed bituminous coal mines of the United States are capable, with a sufficient supply of labor and railroad cars, of producing from 50 to 75 per cent more than even the record-making output of 1910. That is to say that a production of 600,000,000 to 700,000,000 short tons of bituminous coal could be mined in the United States without creating a necessity for opening new properties. Relatively this condition has existed for at least a quarter of a century, the capacity always, and the production frequently, being in excess of the demand. In spite of these conditions, owners of coal lands are constantly inspired to have them developed, possibly in the hope of doing so before conditions become worse. Probably the worst offenders, however, are the railroad companies, which build into new territory partly to secure control of the new tonnage, partly to get the benefit of lower prices of coal for their own consumption, the newer mines being usually capable of producing coal more cheaply than the older ones and also of securing a better complement of men.

In order to meet these conditions and also to meet the general tendency toward increased cost of labor, operators have been impelled to the utilization of labor-saving and expense-reducing machinery, but the change has not always been easily accomplished, and in some States to-day the differentials in mining rates against the machines destroy, or materially reduce, the advantages in cheapness sought to be gained. In addition to the lessening of the mining cost, however, there are two other aims to be accomplished in the use of mining machines. The undercutting of coal by hand is one of the most exacting kinds of labor, and the use of machinery materially mitigates the arduous character of the miner's employment. More important than this, however, is the greater safety secured through reducing the practice, too prevalent in many mining districts, of shooting from the solid. This practice can not be too strongly condemned, for it increases the liability to accident and is contrary to conservation, in that it produces an inordinate quantity of undersirable or unmarketable fuel. It is gratifying to note, therefore, the steady increase in the proportion of coal mined by the use of machines, for it indicates, though it does not actually prove, a larger proportion of coal undercut before being shot down. Recent developments in mining machinery, as mentioned in the report for 1909, have been in the bringing out by several different manufacturers of a type of machine for undercutting or shearing the coal or cutting out clay bands in steeply inclined beds. This new type of cutter is practically the punching machine mounted on a post and radially actuated. Another new type of machine is the "short-wall" or "continuous cutter," which is in reality the application of the principle of the long-wall machine to the pillar and room system of mining. These machines move along the face of the coal, cutting as they go and do not have to be withdrawn the width of the cutting frame after each cut, as with the chain-breast machine.

The number of machines reported in use in the coal mines of the United States in 1910 was 13,254 against 13,049 in 1909, an increase of 205, or 1.6 per cent, whereas the quantity of machine-mined coal increased from 142,496,878 short tons to 174,012,293 tons, a gain of 31,515,415 tons, or 22 per cent. The 13,254 machines in use in 1909 included 6,716 pick or punching machines, 5,973 chain-breast, 518 long-wall, and 47 short-wall or continuous cutters. The post punchers are included in the pick machines, operators not having reported them separately.

Pennsylvania, the leading State in the production of bituminous coal, leads also in the number of machines employed and in the quantity of coal mined by their use; but in the percentage of machine-mined coal to the total product, Ohio far outranks all competitors. The quantity of coal produced by machines in Pennsylvania in 1910 was 68,501,041 short tons, or 45.51 per cent of the total bituminous output of the State, nearly 11,000,000 tons more than in 1909. The total increase for the State was about 12,600,000 tons. Of Ohio's total production in 1910, 84.44 per cent was machine mined, and the increase in the production of machine-mined coal in 1910 over 1909 was larger than the increase in the total output. Ohio also stands second in the quantity of coal mined by machines. Kentucky ranks second in the proportion of machine-mined coal to the total product, with 64 per cent in 1910. West Virginia is third in the quantity of coal mined by machines, with Illinois fourth, and although the total output of Illinois in 1910 was 5,000,000 tons less than in 1909, there was a small increase (250,000 tons) in the machine-mined product.

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, 1906–1910, by States and Territories.

State or Territory.	Number of machines in use.					Number of tons mined by machines.				
	1906	1907	1908	1909	1910	1906	1907	1908	1909	1910
Alabama	238	197	197	283	317	1,641,476	1,762,948	1,783,516	2,203,619	2,980,122
Arkansas					12					13,383
Colorado	141	175	211	253	256	1,337,006	1,689,517	1,668,602	1,929,545	1,905,781
Illinois	1,048	1,080	1,217	1,260	1,361	11,585,419	15,134,401	15,045,004	17,488,427	17,730,298
Indiana	471	513	507	631	645	4,251,740	5,310,607	5,294,092	7,408,829	8,986,495
Iowa	34	33	28	5	17	193,666	108,022	71,463	7,500	22,158
Kansas	6	6	17	16	13	30,450	35,317	133,248	59,976	34,240
Kentucky	600	708	759	877	899	5,175,950	5,504,262	5,252,753	6,461,593	9,362,851
Maryland	45	43	39	39	38	427,450	479,110	208,134	117,568	137,216
Michigan	110	103	120	101	100	417,073	606,718	535,543	511,895	698,191
Missouri	48	62	57	96	96	419,288	486,882	479,850	796,438	553,656
Montana	76	86	57	81	99	974,306	984,368	713,217	840,686	866,401
New Mexico		3	7	4	3		11,615	30,600	1,352	71,609
North Dakota	11	12	11	16	13	97,035	136,700	104,884	112,365	165,366
Ohio	1,255	1,328	1,343	1,433	1,452	20,004,416	24,843,616	19,799,140	22,148,216	28,887,241
Oklahoma (Indian Territory)	29	11	17	34	13	33,357	24,331	31,352	50,812	28,166
Pennsylvania	4,515	4,940	5,103	5,616	5.505	54,146,314	60,771,157	52,447,809	57,504,188	68,501,041
Tennessee	128	137	122	197	178	747,500	874,925	787,502	1,040,798	1,226,672
Texas	12	13	6	11	14	22,682	36,100	15,000	17,230	20,360
Utah	2	5			7	1,000	1,800			24,000
Virginia	37	77	85	107	142	424,343	788,793	1,035,832	1,323,111	2,290,435
Washington	1		4	18	10	12,521		20,000	48,690	56,000
West Virginia	1,322	1,533	1,574	1,844	1,966	15,565,113	17,627,925	16,653,174	20,993,489	27,981,617
Wyoming	83	79	88	127	98	1,339,422	1,328,709	1,072.619	1.430,551	1,468,994
Total	10,212	11,144	11,569	13,049	13,254	118.847,527	138,547,823	123,183.334	142,496,878	174,012,293

State or Territory.	Total tonnage of States using mining machinery.					Percentage of total product mined by machines.				
	1906	1907	1908	1909	1910	1906	1907	1908	1909	1910
Alabama	13,107,963	14,250,454	11,604,593	13,703,450	16,111,462	12.52	12.37	15.37	15.02	18.50
Arkansas					1,905,958					.70
Colorado	10,111,218	10,790,236	9,634,973	10,716,936	11,973,736	13.22	15.66	17.32	18.00	15.99
Illinois	41,480,104	51,317,146	47,659,690	50,904,990	45,900,246	27.93	29.49	31.57	34.00	38.63
Indiana	12,092,560	13,985,713	12,314,890	14,834,259	18,389,815	35.16	37.97	42.99	50.00	48.87
Iowa	7,266,224	7,574,322	7,161,310	7,757,762	7,928,120	2.67	1.43	1.00	.10	.28
Kansas	6,024,775	7,322,449	6,245,508	6,986,478	4,921,451	.51	.48	2.13	.85	.70
Kentucky	9,653,647	10,753,124	10,246,553	10,697,384	14,623,319	53.62	51.19	51.27	60.50	64.03
Maryland	5,435,453	5,532,628	4,377,093	4,023,241	5,217,125	7.86	8.66	4.76	2.90	2.63
Michigan	1,346,338	2,035,858	1,835,019	1,784,692	1,534,967	30.98	29.80	29.18	28.70	45.49
Missouri	3,758,008	3,997,936	3,317,315	3,756,530	2,982,433	11.16	12.18	14.47	21.20	18.56
Montana	1,829,921	2,016,857	1,920,190	2,553,940	2,920,970	53.24	48.81	37.14	32.90	29.66
New Mexico		2,628,959	2,467,937	2,801,128	3,508,321		.44	1.24		2.04
North Dakota	305,689	347,760	320,742	422,047	399,041	31.74	39.31	32.70	27.26	41.44
Ohio	27,731,640	32,142,419	26,270,639	27,939,641	34,209,668	72.14	77.29	75.37	79.50	84.44
Oklahoma (Indian Territory)	2,860,200	3,642,658	2,948,116	3,119,377	2,646,226	1.17	.67	1.06	1.50	1.06
Pennsylvania	129,293,206	150,143,177	117,179,527	137,906,791	150,521,526	41.88	40.48	44.76	41.68	45.51
Tennessee	6,259,275	6,810,243	6,199,171	6,358,645	7,121,380	11.94	12.85	12.70	16.40	17.23
Texas	1,312,873	1,648,069	1,895,377	1,824,440	1,892,176	1.73	2.19	.79	.94	1.08
Utah	1,772,551	1,947,607			2,517,809	.06	.09			.95
Virginia	4,254,879	4,710,895	4,259,042	4,752,217	6,507,997	9.97	16.74	24.32	27.88	35.19
Washington	3,276,184		3,024,943	3,602,263	3,911,899	.38		.66	1.35	1.43
West Virginia	43,290,350	48,091,583	41,897,843	51,849,220	61,671,019	35.96	36.65	39.75	40.80	45.37
Wyoming	6,133,994	6,252,990	5,489,902	6,393,109	7,533,088	21.84	21.25	19.54	22.38	19.50
Total	338,597,052	387,943,083	328,270,373	374,688,540	416,849,752	a 35.10	a 35.71	a 37.52	a 38.03	a 41.74

a Average.

One of the determining factors in the choice of machines for undercutting the coal is the character of the roof, it being impracticable to operate chain-breast machines when the roof is tender and the timbering has to be kept up close to the face. This limitation does not apply to the short-wall or continuous-cutter machines, which can be operated in mines where the timbering is within 3 feet, or even less, of the face. Neither of these machines is so well adapted as the punchers for use in mines where "sulphur balls" (nodules of iron pyrites) are prevalent as the sulphur balls will break or quickly dull the cutting bits, whereas the operator of the puncher can cut around them. The limitations of the chain type of machine (including the continuous cutters) are compensated for, however, by the higher efficiency in the mines where they can be used and by the greater ease with which the wires can be carried through the mines as compared with the air pipes for the punchers. Most of the chain machines are operated by electricity, and compressed air is used to actuate the punchers. It will be observed from the following table that in Ohio where the machine production represents all but 15 per cent of the total, chain-breast machines are largely in the ascendant, while in Pennsylvania, where the largest tonnage is produced, the pick or puncher machines nearly double the number of chain machines. Among the other more important States pick machines are more numerous than the chain machines in Alabama, Colorado, Illinois, Kentucky, and Tennessee, and the chain machines appear to be the more popular in Indiana, Virginia, and West Virginia. Missouri is the only State in which long-wall machines are the more numerous.

In the following table are shown the number and kind of machines in use in each State so far as they were reported to the survey in 1909 and 1910:

Number and kinds of machines in use in 1909 and 1910, by States and Territories.

State or Territory.	1909				1910				
	Pick.	Chain breast.	Long-wall.	Total.	Pick.	Chain breast.	Long-wall.	Short-wall.	Total.
Alabama	192	74	17	283	215	82	20		317
Arkansas					6	6			12
Colorado	175	66	12	253	182	55	19		256
Illinois	845	405	10	1,260	816	543	2		1,361
Indiana	227	391	13	631	194	422	29		645
Iowa	5			5	11	6			17
Kansas	14	2		16	11	2			13
Kentucky	547	310	20	877	536	325	37	1	899
Maryland	39			39	37		1		38
Michigan	66	34	1	101	51	42	4	3	100
Missouri	4	18	74	96	23		73		96
Montana	72	9		81	65	32	1	1	99
New Mexico		4		4		2	1		3
North Dakota	7	9		16	4	9			13
Ohio	97	1,314	22	1,433	104	1,319	24	5	1,452
Oklahoma	28	4	2	34	12		1		13
Pennsylvania	3,847	1,731	38	5,616	3,534	1,872	86	13	5,505
Tennessee	119	54	24	197	131	22	13	12	178
Texas	2	6	3	11	8	6			14
Utah					7				7
Virginia	21	82	4	107	14	118	4	6	142
Washington	15	3		18	10				10
West Virginia	700	1,036	108	1,844	680	1,081	199	6	1,966
Wyoming	85	38	4	127	65	29	4		98
Total	7,107	5,590	352	13,049	6,716	5,973	518	47	13,254

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 of 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
1910	13,256	174,012,293	13,127

Although there are some exceptions to the rule, it generally appears that in the States where the percentages of machine-mined coal have shown marked increase, there have also been noticeable gains in the efficiency of labor as indicated by the average daily tonnage for each man employed. This is shown in the following table, which exhibits the average tonnage per man, the production by machines, and the percentage of the machine-mined coal to the total production in 1908 and 1910, by States. In nearly every State the increases have been coordinate, Montana and West Virginia being conspicuous exceptions. In Montana the proportion of machine-mined tonnage to the total was less in 1910 than in 1908, while the labor efficiency apparently increased; in West Virginia the conditions were reversed.

Average production per man compared with production by machines in 1908 and 1910, by States and Territories, in short tons.

State or Territory.	Average tonnage.				Production by machines.			
	Per year.		Per day.		Total tonnage by machines.		Per cent of machine coal to State total.	
	1908	1910	1908	1910	1908	1910	1908	1910
Alabama	605	725	2.72	2.91	1,783,516	2,980,122	15.37	18.52
Arkansas	389	342	2.68	2.67		13,383		.70
Colorado	663	755	3.13	3.20	1,668,602	1,905,781	17.32	15.99
Illinois	701	632	3.79	3.95	15,045,004	17,730,298	31.57	38.63
Indiana	670	841	3.85	3.67	5,294,092	8,986,495	42.99	48.87
Iowa	447	476	2.09	2.18	71,463	22,158	1.00	.28
Kansas	449	382	2.48	2.58	133,248	34,240	2.13	.70
Kentucky	603	720	3.24	3.26	5,252,753	9,362,851	51.27	64.03
Maryland	720	898	3.27	3.33	208,134	137,216	4.76	2.63
Michigan	432	429	2.09	2.03	535,543	698,191	29.18	45.49
Missouri	369	308	2.18	2.00	479,850	553,656	14.47	18.56
Montana	610	762	2.73	3.19	713,217	866,401	37.14	29.66
New Mexico	716	979	3.63	3.46	30,600	71,609	1.24	2.04
North Dakota	508	747	2.81	3.61	104,884	165,366	32.70	41.44
Ohio	554	733	3.44	3.61	19,799,140	28,887,241	75.37	84.44
Oklahoma (Indian Territory)	341	306	1.98	2.13	31,352	28,166	1.06	1.06
Pennsylvania, bituminous	706	858	3.51	3.61	52,447,809	68,501,041	44.76	45.51
Tennessee	525	597	2.51	2.65	787,502	1,226,672	12.70	17.23
Texas	431	451	1.70	1.93	15,000	20,360	.79	1.08
Utah	693	825	3.05	3.17		24,000		.95
Virginia	686	896	3.43	3.72	1,035,832	2,290,435	24.32	35.19
Washington	552	620	2.73	2.42	20,000	56,000	.66	1.43
West Virginia	737	898	3.98	3.94	16,653,174	27,981,617	39.75	45.37
Wyoming	794	969	3.66	3.91	1,072,619	1,468,994	19.54	19.50

COAL-WASHING OPERATIONS.

A considerable quantity of coal is washed at the mines in order to reduce the percentage of impurities (ash and sulphur) and thus improve the quality of the product. The larger portion of the product so treated is slack used for coke making, but in some cases, as in Illinois and Washington, when the coal is noncoking the washed product is principally nut coal used for domestic fuel. In 1910 the quantity of coke prepared at the mines for coking or for market by washing was 18,395,382 short tons, which yielded 16,035,387 tons of cleaned coal and 2,359,995 tons of refuse. In 1909, 16,541,874 tons of coal washed yielded 14,443,147 tons of cleaned coal and 2,098,727 tons of refuse. Alabama leads in the quantity of coal washed and in 1910 Pennsylvania was second, these two States having a total of about 11,550,000 tons of coal washed, practically all of which was used for coke making.

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 3,296,318 long tons, equivalent to 3,691,876 short tons, were recovered by washing from the old culm banks, against 3,694,470 long tons, or 4,137,806 short tons, in 1909. 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 1909 and 1910:

Bituminous coal washed at the mines in 1909 and 1910, with quantity of washed coal and of refuse obtained from it, by States and Territories, in short tons.

1909.

State or Territory.	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

1910.

State or Territory.	Quantity of coal washed.	Quantity of cleaned coal.	Quantity of refuse.
Alabama	6,772,860	5,971,305	801,555
Arkansas	59,702	44,169	15,533
Colorado	408,374	312,056	96,318
Georgia	84,073	78,208	5,865
Illinois	2,453,208	2,019,396	433,812
Indiana	32,592	29,324	3,268
Kentucky	7,088	6,444	644
Maryland	336	286	50
Michigan	186,128	159.971	26,157
Missouri	52,921	40,748	12,173
Montana	179,565	148,142	31,423
New Mexico	591,611	493,060	98,551
Ohio	174,574	150,707	23,867
Oklahoma	40,790	31,509	9,281
Oregon	38,736	27,115	11,621
Pennsylvania	4,782,246	4,295,439	486,807
Tennessee	571,830	529,111	42,719
Texas	21,296	15,339	5,957
Virginia	13,120	12,696	424
Washington	1,117,166	923,371	193,795
West Virginia	807,166	746,991	60,175
Total	18,395,382	16,035,387	2,359,995

PRICES.

The country as a whole being considered, the average prices of both anthracite and bituminous coal have not shown any material changes in the last seven years or since 1903 when the scarcity of fuel caused by the strike in the anthracite mines resulted in the highest prices in the 30 years that the statistics of coal production have been collected by the Geological Survey. Since 1903 the average price of anthracite has ranged from $2.05 to $2.14 per long ton ($1.83 to $1.91 per short ton) and that of bituminous coal from $1.06 to $1.14 per short ton, the lower figures obtaining in the depression year of 1905 and the higher in the boom year of 1907. In 1898 the average price of anthracite was as low as $1.68 per long ton ($1.41 per short ton) and that of bituminous coal as low as 80 cents per short ton. In 1910 the average price for anthracite was $2.13 per long ton ($1.90 per short ton) and for bituminous coal $1.12 per short ton. The general average in 1910 was 5 cents higher per short ton than in 1909. The following tables show the average prices by States for the last five years, with the advances and declines in 1910 as compared with 1909, and the general averages for anthracite and bituminous prices for 31 years:

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	1910	Advance (+) or decline (−) in 1910.
Alabama	$1.20	$1.21	$1.34	$1.29	$1.26	$1.19	$1.26	+$0.07
Arkansas	1.54	1.49	1.61	1.68	1.68	1.48	1.56	+ .08
California	a 4.74	a 4.97	a 2.55	a 3.81	a 3.19	2.21	a 2.74	+ .53
Colorado	1.31	1.22	1.26	1.40	1.41	1.33	1.42	+ .09
Georgia	b 1.22	b 1.29	1.28	1.38	1.38	1.41	1.46	+ .05
Idaho	c 3.95	c 3.03	c 3.93	d 4.10	4.02	4.27	3.92	− .35
Illinois	1.10	1.06	1.08	1.07	1.05	1.05	1.14	+ .09
Indiana	1.11	1.05	1.08	1.08	1.06	1.02	1.13	+ .11
Iowa	1.61	1.56	1.60	1.62	1.63	1.65	1.75	+ .10
Kansas	1.52	1.46	1.49	1.52	1.49	1.44	1.61	+ .17
Kentucky	1.04	.99	1.02	1.06	1.01	.94	.99	+ .05
Maryland	1.19	1.14	1.19	1.20	1.17	1.11	1.12	+ .01
Michigan	1.81	1.71	1.80	1.80	1.81	1.79	1.91	+ .12
Missouri	1.63	1.58	1.63	1.64	1.64	1.65	1.79	+ .14
Montana	1.61	1.72	1.77	1.94	1.96	1.97	1.82	− .15
New Mexico	1.31	1.33	1.34	1.46	1.37	1.29	1.39	+ .10
North Carolina	(e)	(e)	....	....	....	....	....	....
North Dakota	1.43	1.34	1.54	1.61	1.63	1.56	1.49	− .07
Ohio	1.09	1.04	1.09	1.10	1.06	.99	1.05	+ .06
Oklahoma (Indian Territory)	1.82	1.76	1.92	2.04	2.03	2.00	2.22	+ .22
Oregon	2.18	2.58	2.66	2.34	2.74	2.69	3.48	+ .77
Pennsylvania bituminous	.96	.96	1.00	1.04	1.01	.94	1.02	+ .08
Tennessee	1.18	1.14	1.22	1.25	1.15	1.09	1.11	+ .02
Texas	1.66	1.64	1.66	1.69	1.80	1.72	1.67	− .05
Utah	1.30	1.35	1.36	1.52	1.69	1.66	1.68	+ .02
Virginia	.86	.88	.98	1.02	.91	.89	.90	+ .01
Washington	1.63	1.79	1.80	2.09	2.21	2.54	2.50	− .04
West Virginia	.88	.86	.95	.99	.95	.86	.92	+ .06
Wyoming	1.30	1.31	1.31	1.56	1.62	1.55	1.55	....
Total bituminous	1.10	1.06	1.11	1.14	1.12	1.07	1.12	+ .05
Pennsylvania anthracite	1.90	1.83	1.85	1.91	1.90	1.84	1.90	+ .06
General average	1.26	1.21	1.24	1.28	1.28	1.20	1.25	+ .05

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 31 years.

Year.	Anthracite.	Bituminous.	Year.	Anthracite.	Bituminous.
1880	$1.47	$1.25	1896	$1.50	$0.83
1881	2.01	1.12	1897	1.51	.81
1882	2.01	1.12	1898	1.41	.80
1883	2.01	1.07	1899	1.46	.87
1884	1.79	.94	1900	1.49	1.04
1885	2.00	1.13	1901	1.67	1.05
1886	1.95	1.05	1902	1.84	1.12
1887	2.01	1.11	1903	2.04	1.24
1888	1.91	1.00	1904	1.90	1.10
1889	1.44	.99	1905	1.83	1.06
1890	1.43	.99	1906	1.85	1.11
1891	1.46	.99	1907	1.91	1.14
1892	1.57	.99	1908	1.90	1.12
1893	1.59	.96	1909	1.84	1.07
1894	1.51	.91	1910	1.90	1.12
1895	1.41	.86			

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 1910 were 13,805,866 long tons, valued at $41,470,792, of which 3,021,627 long tons, valued at $14,785,387, were anthracite, and 10,784,239 long tons, valued at $26,685,405, were bituminous coal. The imports of anthracite amounted in 1910 to only 8,195 long tons, valued at $42,244, and those of bituminous coal to 1,497,709 long tons, valued at $3,975,561. The latter includes 317,145 long tons of slack or culm (passing ½ inch screen), valued at $613,078, used for coke making at Everett near Boston, Mass. 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. 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, 1905–1910, 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	24,360,050
1910	3,021,627	14,785,387	10,784,239	26,685,405

Coal imported and entered for consumption in the United States, 1905–1910, 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
1910	8,195	42,244	[a] 1,497,709	3,975,561

[a] Includes 317,145 tons of slack or culm passing ½-inch screen.

WORLD'S PRODUCTION OF COAL.

The total coal production of the world in 1910 was approximately 1,300,000,000 short tons, of which the United States contributed about 39 per cent. This country has far outstripped all others, and in 1910 it exceeded Great Britain, which ranks second, by over 200,000,000 tons. Great Britain's production in 1910 was less than 60 per cent of that of the United States, and Germany's was less than half. The increase in both of these countries in 1910 over 1909 was comparatively small, whereas the increase in the United States was nearly equal to the entire production of France and was more than the total production of any foreign country except Great Britain, Germany, Austria-Hungary, and France.

The United States has held first place among the coal-producing countries of the world since 1899, when it surpassed Great Britain. In the 11 years since 1899 the annual output of the United States has nearly doubled, from 253,741,192 short tons to 501,596,378 tons, whereas that of Great Britain has increased only 20 per cent, from 246,506,155 short tons to 296,007,699 tons.

The table on a later page presents a statement 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.

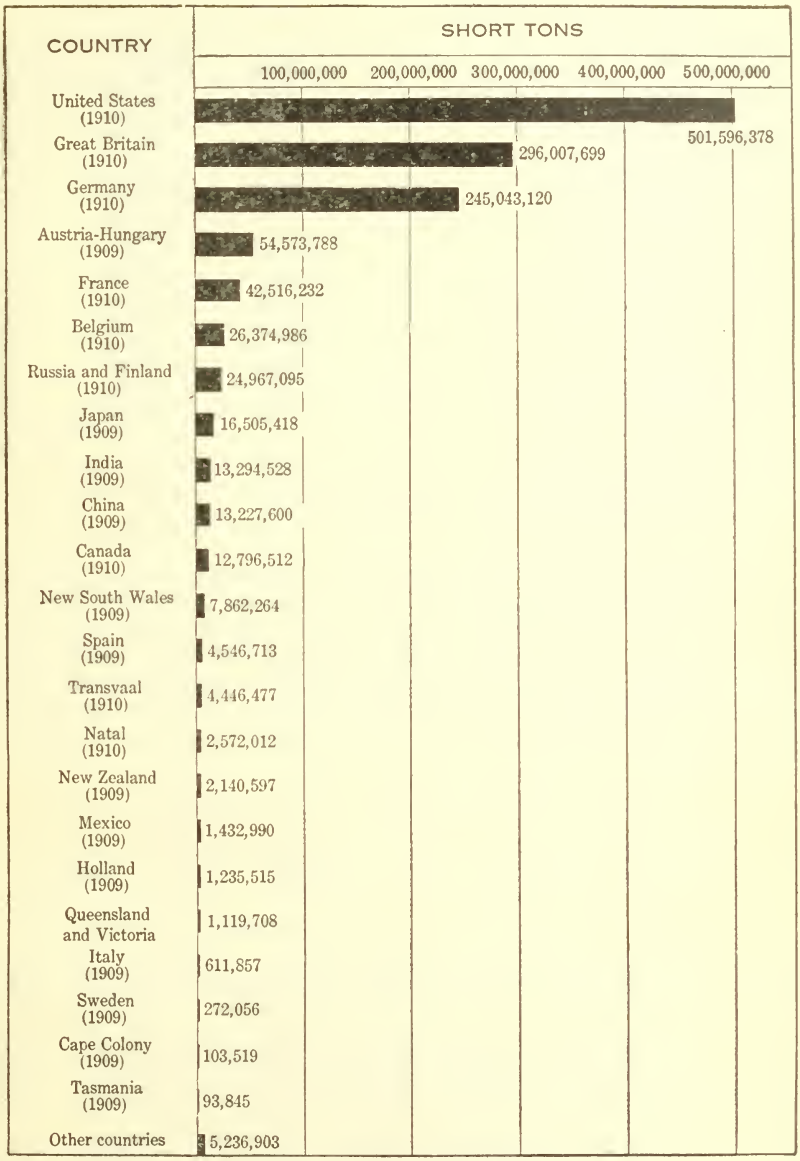


FIGURE 4.—World's production of coal.

The world's production of coal.

Countries.		Usual unit in producing country.	Equivalent in short tons.
United States (1910)	long tons	447,853 909	501,596,378
Great Britain (1910)	do	264,292,588	296,007,699
Germany (1910)	metric tons	222,301,660	245,043,120
Austria-Hungary (1909)	do	49,509,016	54,573,788
France (1910)	do	38,570,473	42,516,232
Belgium (1910)	do	23,927,230	26,374,986
Russia and Finland (1910)	do	22,650,000	24,967,095
Japan (1909)	do	14,973,617	16,505,418
Canada (1910)	short tons	12,796,512	12,796,512
China (1909)	metric tons	12,000,000	13,227,600
India (1909)	long tons	11,870,114	13,294,528
New South Wales (1909)	do	7,019,879	7,862,264
Spain (1909)	metric tons	4,124,751	4,546,713
Transvaal (1910)	long tons	3,970,069	4,446,477
Natal (1910)	do	2,296,439	2,572,012
New Zealand (1909)	do	1,911,247	2,140,597
Mexico (1909)	metric tons	1,300,000	1,432,990
Holland (1909)	do	1,120,852	1,235,515
Queensland and Victoria [a]	long tons	999,739	1,119,708
Italy (1909)	metric tons	555,073	611,857
Sweden (1909)	do	246,808	272,056
Cape Colony (1909)	long tons	92,428	103,519
Tasmania (1909)	do	83,790	93,845
Other countries [b]	do	4,675,806	5,236,903
Total			1,278,577,812
Percentage of the United States			39.2

[a] Queensland figures are for 1910; Victoria, 1909.
[b] Includes Turkey, Servia, Portugal, Chile, Borneo, 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 42 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 37.49 per cent of the world's total, and 39.2 per cent in 1910.

World's production of coal, by countries, 1868–1910.

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

World's production of coal, by countries, 1868–1910—Continued.

Year.	United States.		Great Britain.		Germany.	
	Long tons.	Short tons.	Long tons.	Short tons.	Metric tons.	Short tons.
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	411,441,621	460,814,616	263,774,312	295,427,229	217,433,488	239,676,934
1910	447,853,909	501,596,378	264,292,588	296,007,699	222,301,660	245,043,120

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

World's production of coal, by countries, 1868–1910—Continued.

Year.	Austria-Hungary.		France.		Belgium.	
	Metric tons.	Short tons.	Metric tons.	Short tons.	Metric tons.	Short tons.
1901	41,202,902	45,417,959	32,301,757	35,596,536	22,213,410	24,485,842
1902	39,479,560	43,518,319	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	49,509,016	54,573,788	37,971,758	41,856,269	23,517,550	25,923,395
1910	....	....	38,570,473	42,516,232	23,927,230	26,374,986

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	1,229,176,668	37.49
1910	a 22,650,000	24,967,095	....	....	b 70,993,096	c 1,278,577,812	39.23

[a] These figures also include the production of Finland.

[b] This includes the output of Canada (1910, 12,796,512 short tons); India (1909, 13,294,528 short tons); New South Wales (1909, 7,862,264 short tons); Spain (1909, 4,546,713 short tons); South African Republic (1910, 4,446,477 short tons); New Zealand (1909, 2,140,597 tons); Sweden (1909, 272,056 tons); Italy (1909, 611,857 tons); Queensland (1910, 975,706 tons); also that of Holland, Natal, Cape Colony, Tasmania, Mexico, and Victoria; and of China, Turkey, Servia, Portugal, etc., 24,046,386 tons.

[c] Latest available figures are used in making up totals for 1910.

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 principally 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 1910 has been prepared for this report by Mr. Frederick Hobart, associate editor of the Engineering and Mining Journal:

Although no exact figures are collected covering the coal consumption of Greater New York, a careful comparison of various authorities and a summary of rail deliveries indicate that the city used a total of approximately 16,000,000 tons of coal in 1910, of which 11,500,000 tons were anthracite and 4,500,000 tons were bituminous coal. Owing to the peculiar situation of the city, coal is not delivered directly by rail, but is brought chiefly by the railroads to the chain of coal docks stretching along the New Jersey shore of the harbor and the Hudson River from Staten Island and South Amboy to Weehawken. These docks are in groups around the different railroad terminals, and from them shipments to the city itself are made by barges and car floats. The various groups of coal docks are known technically as the New York Harbor ports or shipping points. This brief explanation is due to those who are not familiar with New York trade.

In addition to the coal consumed in and about the city, there is handled at the harbor shipping ports approximately 10,300,000 tons of coal which is shipped to New England ports, and 4,500,000 tons bunkered, or supplied to steamships. Of the coal destined to New England about 3,500,000 tons is anthracite and 6,800,000 tons bituminous; the bunker coal is practically all bituminous. This makes the total quantity of coal handled through New York Harbor during the year 30,800,000 tons. Not quite all of this is direct-rail coal; about 800,000 tons—perhaps a little more—comes by vessel from Hampton Roads and Baltimore, the former sending Pocahontas and New River coal, and the latter Fairmont and Cumberland coal.

The districts supplying bituminous coal to the New York trade are the Clearfield, the Irwin, and the Somerset in Pennsylvania, the Cumberland in Maryland, and the Fairmont in West Virginia. Some coal comes from the Pittsburgh district, but the regions named are the chief sources of supply.

In 1910 there was no material change in the methods of delivery and distribution of coal in the city itself. The improved deliveries in the Borough of Brooklyn, to which reference has been made in previous reviews, made some advance, but their progress is necessarily slow. In Manhattan the business is essentially one of day-to-day deliveries, owing to the absence of large storage yards and to the difficulty and cost of providing storage at most points. The only consumers who carry habitually more in stock than the needs for a day or two are a few power houses and factories along the river front, and there a considerable part of the stock is habitually carried in the barges which are towed to their docks from across the harbor. The cost of local delivery is high everywhere in the city, and the margin of profit to dealers, contrary to popular impression, is small.

One result of the conditions in Manhattan and Brooklyn has been the crowding out of the smaller dealers. The man with a small yard and three or four teams has been unable to make money, or even a decent living, because his ratio of expenses to income was too high. Year by year the number of such dealers has grown smaller, and now few are to be found. Factory trade went to the big firms long ago, and now house trade is conducted almost entirely by the larger firms, which serve the householders and the peddlers who sell by the 100-pound bag and the bushel to the myriads of tenement and small-flat dwellers.

A feature which has attracted some attention in the city in the last two or three years is the increase in the number of motor wagons in use. It looks as if the motor would in a few years replace the horse entirely in local deliveries. The coal trade is keeping up with the other lines in the general employment of the motor truck.

Anthracite.—The New York market is usually a pretty steady one on anthracite, and 1910 was no exception to the rule. There was no special storage in anticipation of a stoppage of production, for none was anticipated. There was no labor trouble of any importance, mining going on quietly under the settlement made in 1909. The demand for domestic sizes showed little variation. The cold weather of the early months of the year was balanced by a moderately early spring. The winter set in rather early but was not unduly severe. The only change in domestic sales was the moderate increase which is looked for every year from the increase in population, and this is not enough to make a marked difference.

Perhaps the notable incident of the year was the first change in New York tidewater prices made for seven years, or since 1903. For the greater part of the year the old schedule held—$4.75 for lump and $5 for egg, stove, and chestnut, all f. o. b. New York Harbor. The usual summer discounts were made, 50 cents off being allowed on all domestic sizes in April, 40 cents in May, 30 cents in June, 20 cents in July, and 10 cents in August, the discount disappearing on September 1. As in previous years this system worked well, inducing sales and deliveries in the season when coal business would naturally be light. On November 20 the change above referred to was made—an advance of 25 cents per ton on chestnut coal. The reason given was that it was difficult to supply the demand for that size from the breakers, and the companies found it desirable to divert some of the demand to other sizes, if possible. From that date the prices f. o. b. New York Harbor remained $4.75 for lump, $5 for egg and stove, and $5.25 for chestnut.

Retail prices in New York vary from $1.50 to $2 per ton above the tidewater price; that is, where the deliveries are of not less than 1 ton at a time. For the large quantity delivered to tenements and small flats by the 100-pound bag or the bushel the price will figure up to anywhere from $10 to $12 per ton. These differences may seem large, but when the cost of carrying a stock of coal, the cost of wagon delivery, and other charges are considered, there is not a large margin of profit to the retailer, and a large business must be done if he is to secure a good income on the investment and working capital required. The margin of profit on the little business is best, because the small dealer sells entirely for cash; he has no long accounts nor bad debts; his capital invested is small, and he performs most of the work himself. On the other hand, he has to pay the profit of the large retailer from whom he buys his stock.

These conditions have gradually made a wide difference in the domestic trade. The small dealer, with his little yard and two or three wagons, has been crowded out and the business is divided between the big firms on the one hand, and the little dealer—more properly a peddler—on the other. The largest retail firm in New York claims that it handles 1,800,000 tons of coal annually, and there are several others which handle from 500,000 to 800,000 tons, these quantities including steam as well as domestic coal. The change referred to is helped by the constantly increasing number of business buildings and apartment houses heated from central plants which are naturally large buyers, and the corresponding diminution in the number of householders whose purchases are limited to a ton or a few tons at a time. The change is going on in the Borough of Brooklyn and the southern part of the Bronx, as well as in Manhattan. It is a question of only a few years when the householder will survive only in the outlying sections of Brooklyn and the Bronx, and in the Borough of Queens.

In the trade in the small or steam sizes there was little change during the year. A large part of this trade is with the public utilities—power houses, electric-light stations, and the like—and with the large factories, most of it on yearly contracts. As has been heretofore explained, nobody carries large stocks of coal, and even the contract business consists mostly of day-to-day deliveries, in many cases made by trucks direct from the docks, and not out of yard stocks. In January and February there was much cold and stormy weather, which interfered with barge delivery at the docks and made wagon hauling through the streets slow and difficult. For two or three weeks trucks could not carry more than half loads. For the rest of the year trade went on smoothly.

Prices of steam sizes did not vary much until November, when a general advance was made. For 10 months of the year a fair average was: Pea, $2.95 to $3.25; buckwheat, $2.20 to $2.50; No. 2 buckwheat or rice, $1.65 to $2; barley, $1.35 to $1.50, all per long ton. These prices are f. o. b. New York Harbor, according to quality, the lower prices being usually for washery coal. Two or three times during the year there was a little scarcity of buckwheat or rice, and premiums of 5 to 10 cents per ton were paid. Again, especially in July and August, some lots of pea and buckwheat were offered at 5 or 10 cents off by individual operators. The November quotations, which held till the end of the year, were: Pea, $3 to $3.25; buckwheat, $2.30 to $2.75; No. 2 buckwheat or rice, $1.85 to $2.25; No. 3 buckwheat or barley, $1.40 to $1.75; all f. o. b. New York Harbor.

Bituminous.—The bituminous coal trade in 1910 was rather a disappointment. Prices were low for the greater part of the year, trade was irregular, and the demand for coal less than had been expected.

January opened with the trade in bad shape, chiefly owing to the severe December storms. Transportation on the railroads was slow and irregular. Stormy weather and ice interfered with harbor deliveries, and the hauling through the streets was bad. Prices quoted were $2.55 to $2.60 f. o. b. harbor ports for a fair Miller vein steam coal, and up to $3 for better sorts. Gas coal was scarce for the time, and premiums of 10 and 15 cents a ton were paid for coal needed. These conditions lasted through the greater part of the month. In February conditions improved gradually. Car supply and transportation were better, and supplies came in more freely. Gas coal was in sufficient supply and trade ran along more evenly, though there was no special activity manifest. On steam coal prices remained about as in January; gas coal was quoted at $1 to $1.10 at mine for lump, $1 for run-of-mine, and 75 to 80 cents for slack.

April was a fair month, as the coastwise trade opened and there was a good demand from New England. There were, however, some disquieting rumors that New River coal had been offered at very low prices to large consumers in New England. Contract making, usually brisk in April, went very slowly, consumers asking a reduction from 1909 prices, which dealers were not willing to grant. The Panama contracts let during April were taken by Pocahontas producers at $2.63 to $2.75 per ton, delivered on dock at Norfolk.

Toward the end of April the effects of the strike in the western coal mines began to be felt in New York. A good deal of coal from mines which usually ship to the seaboard was going to the West. Prices accordingly advanced all around, and by May 1 a good average steam coal was $2.75 f. o. b. New York Harbor, with better grades up to $3.10. These prices held until nearly the end of May, when there was a drop of 10 cents, under the influence of the partial settlements in the West and the resumption of mining there.

In June West Virginia competition made itself felt. It was understood in New York that good coal was sold in considerable lots at $2.40 f. o. b. Newport News or Norfolk. Both harbor and coastwise trade was dull and prices were weak. A good Miller vein steam coal sold at $2.65 f. o. b. New York Harbor, with a range of 20 cents below and 25 cents above that, for lower and better qualities. By the end of the month these prices had eased off 10 cents. Gas coal sold on a basis of $1 at mine for run of mine. Car supply was good and coal came to tide so plentifully that the lower prices held all through July. Business in that month was quiet and coal almost too plentiful. In fact, some lots of Clearfield were sold as low as $2.20 and $2.25, to avoid demurrage charges.

Through August and September trade remained dull and quiet, with very little change in prices, except that the demand for gas coals improved in September, and there was a little shortage of gas slack, which sent the price of that size up to 65 and 70 cents at mine.

In October harbor trade improved to some extent. In coastwise business the shoal-water ports, which have to put in their winter supplies before ice makes, began to realize that winter was coming. The result was fair buying and prices advanced, good steam coal selling at $2.65, with better grades up to $3.05. Gas coals sold at $1.10 for lump, $1 for run of mine, and 70 cents for slack, all at mines. Car supply began to fall off, and transportation was slower. The strong coastwise demand kept prices up through November. It was helped by an improvement in harbor sales, and by the news that the New River operators had agreed to reduce their tidewater shipments and to try to maintain prices at a better level. Through the latter part of November prices of steam coal held at $2.85 up to $3.25 f. o. b. New York Harbor, according to quality. Gas coals sold at $1.20 to $1.25 at mine for lump; $1.10 to $1.15 for run of mine, and 85 cents for slack, all at mines.

In December car supply improved, the coastwise trade fell off, and harbor demand was less pressing. Prices fell off gradually. Car supply was better, and coal was abundant. By December 20 the market had settled down into general dullness. The closing prices for steam coals, f. o. b. harbor points were $2.55 to $3.10, according to quality; for gas coals at mines, $1.05 for lump, 95 cents for run of mine, and 70 cents for slack.

A noticeable feature of the year was the amount of business done on the open market by consumers who usually cover their requirements by yearly contracts. In no recent year has so small a proportion of the business been covered by such contracts. Many large consumers thought it better to trust to the open market, and in 1910 they were justified by the results.

The coastwise and harbor trade.—The opening of the year found the coastwise trade in bad shape, as a result of the severe storms which marked the closing week of 1909. Many vessels were laid up, others were held at eastern ports, and owners were not willing to take charters. For shipments from New York to points around Cape Cod from 80 to 90 cents was paid; even $1 in some cases. The weather also interfered with movement in the harbor and 25 or even 30 cents was paid to barges. This condition held all through January and most of February. It was not until the middle of March that rates began to settle down to a normal basis. Then boats were in better supply, and rates began to weaken. They continued irregular, however, until spring fairly opened, in April. Then the tendency began to be downward, as vessels were abundant and the demand moderate, owing to the light and unfavorable opening of the New England trade. By the middle of April rates from New York were 60 to 65 cents to Boston and Portland, and 75 cents to most of the shoal-water ports. Harbor barge rates had settled down to the normal level of 15 to 18 cents some time before.

Conditions showed little change until the end of May, when vessels became rather scarce—partly owing to increased demand and partly to diversion of boats to the southern lumber trade—and rates strengthened, 70 to 75 cents being paid from New York to points beyond Cape Cod, with 10 cents more to the shoal-water ports; while 30 to 45 cents was paid to Providence and Long Island Sound ports. Freights held up through June, and in the middle of July 75 to 80 cents was paid from New York to points beyond Cape Cod, with the usual advance to towage ports. Another 5 cents was added in July. In August, however, trade began to fall off; coal shipments were lighter, and quite a fleet, which had been in the lumber trade, was released. Vessels were abundant, and conditions were reversed;

instead of shippers hunting for boats, shipowners were hunting charters. This brought about a sharp fall in rates and cargoes were taken at 50 to 60 cents from New York to Boston and Portland; in some cases even 45 cents was accepted.

Vessels remained in good supply and rates unchanged, with an easy tendency until October, when the rush to get coal to the shoal-water ports began. Then there was an advance, 60 to 65 cents being charged from New York to Boston and Portland, with 10 or 15 cents additional to towage ports, and 35 to 45 cents to Sound ports and Providence. These rates held well into November, when an upward tendency was manifest. By the end of the month 70 to 75 cents was charged from New York to points around Cape Cod. In December stormy weather kept boats back, but by that time trade had fallen off and the year closed with charters taken at the same figures, 70 to 75 cents to points around Cape Cod, 50 to 55 cents to Providence and New Bedford, and 35 cents to Sound ports.

There was much less complaint than usual about delays in unloading, and for most of the year the loading and unloading clause in charters was not enforced. In part this was due to improvements in coal handling, chiefly at the Sound ports, and to prompter railroad service from those ports; in part to lighter trade resulting from the diversion of coal trade with western New England to the all-rail line by way of the Poughkeepsie bridge. The New York, New Haven & Hartford Railroad began also to make some improvements in methods of handling and distributing coal from its receiving points.

The greater part of the anthracite shipped from New York Harbor is now handled by the barge lines owned by the big coal companies. The sailing vessel, however, holds its own in the bituminous trade, the old "wind-jammers" carrying most of the soft coal. Steam colliers are not largely employed, except by two companies. The barges are generally moved by sea-going tugs.

Coastwise shipments of coal from New York Harbor coal delivery ports for four years past are reported as follows:

Shipments of coal from New York harbor points, 1907–1910, in long tons.

	1907	1908	1909	1910
Anthracite	16,753,914	15,069,981	14,418,292	15,036,622
Bituminous	11,691,101	10,247,014	10,549,974	11,289,095
Total	28,445,015	25,316,995	24,968,266	26,325,717

As compared with 1909 the year 1910 showed an increase of 618,330 tons in anthracite, and 739,121 tons in bituminous coal; a total gain of 1,357,451 tons, or 5.4 per cent. Although no exact division of these shipments can be made, about 60 to 65 per cent was barge shipments to city and neighboring wharves, the rest going to New England ports chiefly. New York does practically no off-shore business, exports to foreign countries being made principally from Hampton Roads, Baltimore, and Philadelphia.

BOSTON, MASS.

The following review of the coal trade of Boston in 1910 has been prepared by Mr. Robert S. Coffin, secretary of the committee on fuel supply of the Boston Chamber of Commerce:

Receipts and shipments.—The year 1910 broke all previous records for the receipts of coal at the port of Boston. The aggregate tonnage of anthracite and bituminous amounted to 6,230,022 long tons as against 5,429,967 long tons in 1909, an increase of 800,055 tons over that year and approximately 500,000 tons greater than the receipts of any previous year. Of this tonnage, 1,826,164 long tons were anthracite, 4,107,294 tons were bituminous, and 296,564 tons were foreign. This was an increase of 119,505 tons of anthracite, 612,283 tons of bituminous, and 68,267 tons of foreign bituminous. There has been some speculation as to the reason for so great an increase in the receipts of bituminous coal, and it can probably be accounted for by a combination of the following reasons: First, a further recovery from the depressed business conditions which prevailed during the period 1907–8; second, a very considerable industrial growth in Boston and vicinity; third, increased traffic on steam and electric railroads.

Other reasons may also have influenced the situation—as, for example, the steadily increasing number of modern coal steamers which have been put into the coal-carrying trade between Boston and southern ports, the establishment of modern loading and unloading plants, all of which tends to reduce the transportation rates to the larger ports, especially Boston, and has resulted in diverting quantities of coal to Boston which otherwise would have gone to the smaller ports.

A considerable portion of the coal received at Boston is forwarded over the railroads to interior points. In 1910, 241,641 tons, or about 13 per cent, of the anthracite tonnage and 743,635 tons, or about 17 per cent, of the bituminous tonnage received at Boston was forwarded to interior New England points. The net receipts for local consumption amounted to 1,584,523 tons of anthracite and 3,660,223 tons of bituminous coal.

The following table shows the receipts both of anthracite and of bituminous coal at Boston, by months, for 1910, the quantities forwarded to interior points, the net receipts for local consumption, and the totals for 1910 as compared with the three preceding years:

Receipts and shipments of coal at and from Boston in 1910, by months, in long tons.

	Receipts from all points.		Shipments to New England points.		Net receipts (for local consumption).	
	Anthracite.	Bituminous.	Anthracite.	Bituminous.	Anthracite.	Bituminous.
January	136,978	294,240	18,364	50,353	118,614	243,887
February	112,003	306,675	16,820	65,633	95,183	241,042
March	153,582	451,110	16,021	84,761	137,561	366,349
April	155,413	397,581	29,616	57,154	125,797	340,427
May	185,025	377,797	24,554	51,095	161,471	326,702
June	154,177	364,190	18,517	42,050	135,660	322,140
July	107,974	354,592	15,600	49,949	92,374	304,643
August	140,832	396,234	17,139	61,421	123,693	334,813
September	160,855	389,194	15,768	72,705	145,087	316,489
October	169,738	407,998	20,014	83,432	149,724	324,566
November	147,871	307,485	23,108	77,444	124,763	230,041
December	201,716	356,762	27,120	47,638	174,596	309,124
Total, 1910	1,826,164	4,403,858	241,641	743,635	1,584,523	3,660,223
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	2,542,962
1907	2,053,288	3,831,636	281,633	854,347	1,771,655	2,977,289

Anthracite.—A brief survey of the table given below brings out a rather surprising fact, namely, that for the last eight years the local anthracite trade has been scarcely holding its own, and certainly not when the estimated allowance of 5 per cent per annum for the increase in population is considered. This view is further strengthened when one realizes that within the last few years the tonnage of anthracite screenings used in mixture with bituminous coals has been steadily increasing. This falling off in the consumption of anthracite is attributed to the increasing consumption of coke, gas, and electricity for domestic use. The loss of tonnage due to this transition has been conservatively placed by some of the leading coal dealers in this city at between 100,000 tons and 150,000 tons within the last few years.

Receipts of coal at Boston, Mass., for eight 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
1910	1,760,883	3,954,251	65,281	153,043	....	296,564	6,230,022

Retail prices of anthracite.—Below is given a table showing the retail prices of anthracite for 1910. The summer prices went into effect on April 1, 1910, and remained unchanged until July 1, when all sizes were advanced 25 cents per ton. These prices held until September 1, when a further advance of 25 cents per ton was made in all sizes, with the exception of furnace and pea. The prices for the year 1910 were practically the same as for the previous year, with the exception that in 1909 the summer prices remained unchanged until September 1, and all sizes, with the exception of pea, were then advanced 50 cents per ton.

Retail prices, per long ton, of anthracite at Boston in 1910, by kind.

Kind.	Apr. 1.	July 1.	Sept. 1.	Kind.	Apr. 1.	July 1.	Sept. 1.
Furnace	$6.25	$6.50	$6.50	Pea	$5.25	$5.50	$5.50
Egg	6.75	7.00	7.25	Shamokin	7.00	7.25	7.50
Stove	6.75	7.00	7.25	Franklin	8.00	8.25	8.50
Nut	6.75	7.00	7.25				

Foreign coal.—The receipts of foreign coal were almost exclusively from the bituminous mines of the Dominion Coal Co. in Cape Breton, practically all of which was delivered to the by-product coking plant at Everett, a suburb of Boston. It is apparent from the table showing the receipts of domestic and foreign coals at the port of Boston for the period of eight years that the reduction in duty on Canadian coals from 67 cents per ton to 45 cents per ton under the Payne-Aldrich tariff has not resulted in an increased demand for Nova Scotia coal.

Coastwise freight rates.—The coastwise freights in 1910 were about normal, although slightly lower than in 1909. From Hampton Roads the minimum rate in 1910 was 50 cents per ton and the maximum rate was 80 cents per ton, as compared with rates ranging from 60 cents to 90 cents in 1909; the rates from Philadelphia in 1910 ranged from 50 cents to 90 cents, as against 60 cents and 90 cents in 1909; and from Baltimore the rates ranged from 60 cents to 90 cents, as against 70 cents and $1 in 1909.

Coal freights to Boston during 1909 and 1910.

1909.

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

1910.

From—	Minimum rate	Minimum date	Maximum rate	Maximum date
New York	[a] $0.50–$0.55		$0.85	Dec. 15.
Philadelphia	.50	Aug. 15	.90	Dec. 10–15.
Baltimore	.60	Aug. 5–25	.90	Dec. 15.
Norfolk and Newport News	.50	June 15–Dec. 15	.75–.80	Dec. 15–25.

[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 1910 presented no new features worthy of comment in regard to the coal trade itself. Mention has already been made of the introduction of modern unloading plants at the receiving ports and of the improved transportation facilities by water through the introduction of modern coal steamers built especially for the coal-carrying trade. The year 1910 witnessed an addition of 2 new colliers, making in all 7 modern coal steamers engaged exclusively in the coal-carrying trade between Boston and the southern coal ports, with a total carrying capacity of about 50,000 tons. Two additional steamers are now under construction, and when these have been added to the service Boston will have a coal fleet which is unsurpassed.

PHILADELPHIA, PA.

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

The year 1910 was the second best in the history of the anthracite coal trade, the total shipments amounting to 64,905,786 long tons. Although this tonnage compares favorably with the largest quantity ever produced, there were dull periods during the year, which caused the small operators to sell their coal considerably below the circular prices issued by the large companies. Very few of the individual operators have a large storage capacity, so when the coal does not move promptly they are faced by the alternative of either closing their mines or of selling their product at the best price they can get. The large companies, however, held firm, and in no case was there any evidence of meeting the prices made by the independent operators. There was no interruption to anthracite mining by strikes or other labor trouble. The few isolated cases in which the services of the board of conciliation were demanded were quickly and amicably settled.

As has been the case for several years, on April 1, 1910, a reduction of 50 cents per ton was made on anthracite, which reduction was restored at the rate of 10 cents a month until in September the full circular prices were in force. In the first six and the last three months of the year the shipments of anthracite were heavy. The good demand with which the year began continued until the end of May, when the trade became very dull. In the months of June, July, and August little coal was sold, and the stocks increased rapidly. This was the period when the individual operators were offering coal at much lower prices than those quoted by the larger companies.

As in 1908 and 1909, some of the mines were at times compelled to shut down owing to a scarcity of water, and a number of the large companies were forced to haul water to keep their plants in operation.

The total shipments of anthracite from the mines in 1910 were 64,905,786 long tons, as against 61,969,885 tons in 1909 and 64,665,014 tons in 1908. The largest shipments were in 1907, when 67,109,393 long tons were sent to market. These figures include only the tonnage forwarded from the mines and do not take in the coal used at and around the coal plants. During 1910 the shipments in the months of April, November, and December each were over 6,000,000 long tons; in July, August, and September they were less than 5,000,000; in each of the other six months the shipments amounted to over 5,000,000 tons. The shipments to Philadelphia in 1910 increased 53,968 tons, as compared with 1909.

The coal companies during the year had some trouble in meeting the demand for chestnut size. The increasing popularity of that size for domestic use makes it highly probable that it will be excepted from the usual spring reductions in price. The consumption of chestnut coal has increased so rapidly that difficulty is experienced in keeping the balance with other sizes. Buckwheat, rice, and other small sizes, which a few years ago were only lightly dealt in, are now extensively used, and better prices are being obtained for them. The local consumption of bituminous coal continues to show a steady increase, and more factories are using soft coal every year. Although the consumption of bituminous coal in 1909 was large, being 2,292,143 tons, there was an increase in 1910 of 98,515 tons. The storage and shipping facilities at Philadelphia have been greatly improved, and vessels can now be more speedily loaded than formerly. The demand for coal by the manufacturers in Philadelphia took a decided drop about the middle of the year, and quite a number were only working on part time.

The stocks of anthracite on hand in the yards and plants of the coal-producing companies at the beginning of 1910 were very large, but owing to the big demand during the months of January, February, and March a considerable depletion was made. The coal trade remained fairly firm until the latter part of May, when the demand became light and prices were shaded even beyond the usual spring reductions.

The shipments for export in anthracite from the port of Philadelphia in 1910 were 72,733 long tons, an increase of 8,243 tons over 1909. The shipments for coastwise and harbor trade decreased 157,846 tons, the total shipments being 1,606,373 tons in 1910 against 1,764,219 tons in 1909. The shipments of bituminous coal by water were somewhat larger in 1910 than in 1909.

The following table shows the average range of retail prices of anthracite and bituminous coal during 1910 by months:

Average prices for anthracite and bituminous coal at Philadelphia in 1910, by months, per long tons.

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	6.75– 7.00	4.75	3.35– 3.75	2.75– 3.10	3.75– 4.00
April	6.00– 6.50	$4.25– 4.50	3.20– 3.50	2.75– 3.10	3.75– 4.00
May	6.25– 6.50	4.25– 4.50	3.20– 3.50	2.75– 3.10	3.50– 4.00
June	6.25– 6.50	4.25– 4.50	3.25– 3.50	2.50– 3.00	3.00– 4.00
July	6.25– 6.60	4.00– 4.50	3.25– 3.50	2.50– 3.00	3.00– 4.00
August	6.25– 6.50	4.00– 4.50	3.20– 3.75	2.50– 3.10	3.00– 4.00
September	6.40– 6.75	4.25– 4.50	3.35– 3.75	2.50– 3.10	3.25– 4.00
October	6.40– 6.75	4.25– 4.75	3.35– 3.75	2.50– 3.10	3.25– 4.00
November	6.50– 6.75	4.25– 4.75	3.35– 3.75	2.50– 3.10	3.40– 4.00
December	6.50– 6.75	4.50– 4.75	3.35– 3.75	2.50– 3.10	3.50– 4.00

The production of anthracite coal during 1910 was the second largest in the history of anthracite mining. If it had not been that some of the mines were compelled to shut down during the drought, it is believed that the production would have been the largest in the history of the trade.

The following table shows the shipments of 1910 as compared with 1909:

Anthracite shipments in 1909 and 1910, by months, in long tons.

Month.	1909	1910	Month.	1909	1910
January	5,183,345	5,306,618	August	4,198,273	4,996,044
February	4,576,004	5,031,784	September	4,416,120	4,967,516
March	6,332,474	5,174,166	October	5,579,759	5,622,095
April	5,891,176	6,224,396	November	6,027,800	6,071,746
May	5,063,873	5,679,661	December	5,775,438	6,231,578
June	4,904,858	5,398,123			
July	4,020,765	4,202,059	Total	61,969,885	64,905,786

Although there was an increase of 8,234 tons in anthracite for export, the coal was shipped to only six countries, 37,077 tons going to Cuba; 23,991 tons to Canada; 8,921 tons to Newfoundland; 1,353 tons to Santo Domingo; 1,284 tons to Bermuda; and 107 tons to British West Indies. The value of these shipments amounted to $312,519.

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.	Buck-wheat.
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 Co., the Philadelphia & Reading Railway Co., the Lehigh Coal & Navigation Co., and the Baltimore & Ohio Railroad Co., 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 1909 and 1910, in long tons.

Destination.	1909		1910	
	Anthracite.	Bituminous.	Anthracite.	Bituminous.
Export	64,499	767,284	72,733	794,015
Coastwise and harbor	1,764,219	4,114,620	1,606,373	4,236,476
Local	3,990,677	2,292,143	4,160,953	2,390,658
Total	5,819,395	7,174,047	5,840,059	7,421,149

The price circular of the Philadelphia & Reading Coal & Iron Co., which is the same as that of other companies, is as follows:

Circular prices for anthracite coal at the mines in 1909 and 1910.

Size.	April.	September.
Lump	$3.50	$3.50
Steamboat	3.00	3.00
Broken	3.00	3.50
Egg	3.25	3.75
Stove	3.25	3.75
Chestnut	3.25	3.75
Pea	2.00	2.00
Buckwheat	1.50	1.50

The bituminous coal trade was in a chaotic condition during the entire year; prices were freely cut, although there was a fair demand for the higher grades, and shipments to this port showed an increase. The exports of bituminous coal in 1910 were 27,731 tons more than in 1909, the total shipments amounting to 794,015 tons. The largest quantity, 421,012 tons, was sent to Cuba; Italy was second, with 109,609 tons; Mexico received 87,941 tons, and French West Indies 65,738 tons. Canada took only 1,248 tons in 1910, as compared with 135,844 tons in 1909. Shipments to Ecuador were 14,616 tons; to Costa Rica, 11,504 tons; to France, 15,441 tons; and to Austria-

Hungary, 15,140 tons. Only 6,830 tons were sent to Panama. The total value of the bituminous coal shipped from Philadelphia to points outside of the United States in 1910 was $2,193,226, as against $2,011,507 in 1909.

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 in Baltimore in 1910 showed an increase as compared with 1909, as well as an increase over 1908. The receipts of bituminous coal at Baltimore in 1910 aggregated 5,083,673 long tons, as compared with 4,321,194 long tons in 1909. The coastwise coal shipments also showed an increase in 1910 over 1909 amounting to 4,052,815 tons; these shipments were the largest for any year in the history of the port with the exception of 1907, when they aggregated 4,070,128 tons. There was also an increase in the exports of coal and coke, there being 493,416 tons of bituminous coal and 46,487 tons of coke exported in 1910, as compared with 332,016 tons of bituminous coal and 50,446 tons of coke in 1909.

The bituminous coal trade was not entirely satisfactory during the year, although it showed considerable improvement over the year 1909, the latter being considered very poor and conditions irregular, with low prices extending throughout the year. The improvement in 1910, therefore, may be considered as a return to normal conditions.

The anthracite trade was fairly good throughout the year, the receipts of hard coal in 1910 being 809,578 long tons as compared with 746,421 long tons in 1909 and with 792,569 long tons in 1908. This branch of the coal business is, of course, controlled to a greater or lesser degree by weather conditions, practically all the hard coal received at Baltimore being used entirely for household purposes.

The following tables show the receipts and shipments of coal at Baltimore, the coastwise shipments from this port as well as the exports, and the coal and coke received by the Maryland Steel Co. and the Central Foundry Co., two institutions lying outside the city, but which should doubtless be considered in arriving at the total coal business of the city of Baltimore:

Receipts and shipments of coal at Baltimore, Md., 1909–1910, in long tons.

	1909			1910		
	Receipts.	Tidewater shipments.		Receipts.	Tidewater shipments.	
		Coastwise.	Exports.		Coastwise.	Exports.
Bituminous	4,321,194	[a] 3,344,225	332,016	5,083,673	[a] 3,891,018	493,416
Anthracite	746,421	235,233	935	809,578	272,695	3,048
Total	5,067,615	3,579,458	332,951	5,893,251	4,173,713	496,464
Coke (short tons)	144,093	....	50,446	233,501	....	46,487

[a] Includes shipments to Chesapeake Bay points and Baltimore harbor.

Coastwise coal shipments from Baltimore, 1903–1910, 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	3,579,458
1910	272,695	3,780,120	4,052,815

The exports of bituminous coal and coke from Baltimore, by months, for the year 1910, and the totals for the seven preceding years are shown in the following table, from which it will be seen that the exports for 1910 were the largest for a number of years with the exception of 1907:

Exports of bituminous coal and coke from Baltimore in 1910, by months, in long tons.

Month.	Bituminous coal.	Coke.
January	34,224	4,545
February	39,001	91
March	53,785	10,193
April	45,292	468
May	52,779	4,277
June	34,340	4,303
July	42,531	4,044
August	41,606	146
September	48,349	4,485
October	29,492	10,121
November	31,477	253
December	40,540	3,561
Total, 1910	493,416	46,847
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 has been the custom in previous years, the receipts of coal and coke at the plants of the Maryland Steel Co. and the Central Foundry Co. are given in the following paragraphs. The former is about 8 or 9 miles and the latter about 6 miles from the city, but they should be taken into consideration in compiling the coal tonnage of the port of Baltimore.

Maryland Steel Co.—The consumption of bituminous coal at the plant of the Maryland Steel Co. in 1910 amounted to 617,759 long tons, as compared with 517,280 long tons in 1909 and with 414,279 long tons in 1908. These works also consumed 137,499 long tons of coke purchased from outside sources, in addition to the coke manufactured at its own plant, as compared with 54,226 long tons in 1909 and with 10,064 long tons in 1908.

Central Foundry Co.—The plant of the Central Foundry Co. consumed 4,036 tons of bituminous coal and 3,760 tons of coke in 1910, as compared with 4,285 tons of coal and 4,345 tons of coke in 1909 and with 1,754 tons of coal and 2,298 tons of coke in 1908.

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 coal, reaches tidewater at Hampton Roads over the Chesapeake & Ohio, the Norfolk & 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. In 1910 the quantity of coal dumped at Sewall Point was 1,147,077 long tons. The Norfolk & Western Railway transports Pocahontas coal to Lambert Point piers, near Norfolk, and New River coal is sent over the Chesapeake & 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 export trade at Hampton Roads was unusually good and was sustained throughout the entire year. There was a temporary lull during the summer, but at no time could the market be called dull, and the months without exception compared favorably with the corresponding periods of former years.

The coastwise trade was not quite as satisfactory, taken as a whole, as the first of the year promised. It held up fairly well, but in proportion to the foreign business done was disappointing. Local trade exceeded all previous records.

Mr. Saward's report gives the aggregate receipts in 1910 at the three shipping places—Lambert Point, Newport News, and Sewall Point—at 9,597,574 long tons, against 8,455,924 long tons in 1909, and 6,398,344 tons in 1908. The increase in 1910 over 1909 was 1,141,650 long tons, notwithstanding a decrease of nearly 600,000 tons in the shipments over the Chesapeake & Ohio Railway to Newport News. The decrease in the Chesapeake & Ohio shipments is ascribed by Mr. Saward to the exploitation by the producers in the New River and Kanawha districts of the western markets, a campaign that was made easy and profitable by the long strike in the Middle States. Some of the Chesapeake & Ohio tonnage was also probably transferred to the Virginian Railway, whose shipments to Sewall Point increased from 241,644 long tons in 1909 to 1,147,077 tons in 1910. The shipments over the Norfolk & Western Railway increased from 3,228,854 long tons to 4,040,649 tons.

The Coal Trade gives the shipments from southern West Virginia to Hampton Roads for the last five years as follows:

Shipments of coal to Hampton Roads, 1906–1910, in long tons.

Year.	Norfolk & Western Ry. to Lambert Point.	Chesapeake & Ohio Ry. to Newport News.	Virginian Ry. to Sewall Point.
1906	3,021,410	3,509,539	....
1907	3,221,010	3,887,804	....
1908	2,401,223	3,997,121	....
1909	3,228,854	4,985,426	241,644
1910	4,040,649	4,409,848	1,147,077

Receipts and shipments of coal at Newport News, Va., 1906–1910, in long tons.

Calendar year.	Receipts.	Coastwise trade.	Exports.	Bunker trade.
1906	3,153,517	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
1910[a]	4,640,668	3,504,525	733,212	402,931

[a] The statistics for 1910 were furnished by Mr. E. D. Hotchkiss, general freight agent of the Chesapeake & Ohio Railway Co.

PITTSBURGH, PA.

The city of Pittsburgh, with a population in 1910 of 533,905, consumes nearly as much coal as the city of Greater New York with a population of 4,766,883. The total shipments of coal to and through Pittsburgh exceed the movement in New York Harbor, including the local consumption, by nearly 50 per cent. As near as can be ascertained, there were 15,600,654 tons of coal consumed in the Pittsburgh district in 1910. The consumption of coal in the city of New York is estimated at 17,500,000 short tons. The total movement of coal to and from the Pittsburgh district in 1910 was nearly 51,000,000 short tons. The total movement of coal in New York Harbor, including the consumption of the city, was about 33,500,000 tons. The following statement showing the quantity of coal received in Pittsburgh and vicinity by rail and water and the shipment of coal to and from the Pittsburgh district and to western points during the last five years has been compiled by reports made to the Geological Survey by the officials of railroads entering Pittsburgh and by the United States Army officer in charge of the slack-water navigation on Monongahela River, and of the improvements at the Davis Island Dam in Ohio River below Pittsburgh. 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 Pittsburgh, at Pittsburgh; W. L. Cromlish, coal and coke agent of the Baltimore & Ohio Railroad, at Pittsburgh; J. B. Nessle, general freight agent of the Pittsburgh & Lake Erie Railroad, at Pittsburgh; J. B. Safford, superintendent of the Pittsburgh, Chartiers & Youghiogheny Railway, at Pittsburgh; and S. P. Woodside, general freight agent of the Wabash Pittsburgh Terminal Railway, at Pittsburgh. 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, United States Army.

In the total movement of coal to Pittsburgh and points west thereof there was an increase in 1910 over 1909 of 4,217,101 short tons, most of which was in the movement of coal by rail to points west of Pittsburgh. The rail shipments to the Pittsburgh district increased about 1,500,000 tons, while the water shipments fell off about 275,000 tons. The water shipments to western points were cut down by low water in Monongahela and Ohio rivers, and the rail shipments to western points were increased by the strike in the Illinois and southwestern fields. The total shipments to the Pittsburgh district by rail and water increased from 14,391,754 short tons in 1909 to 15,600,654 tons in 1910. The shipments to points west of Pittsburgh increased from 21,445,380 short tons to 24,453,581 tons. The total shipments by rail to Pittsburgh and to points west increased 5,186,991 tons in 1910 over 1909, while the total water shipments decreased nearly 1,000,000 tons. These figures do not include any coal mined in the Pittsburgh district and shipped to eastern points nor do they include any shipments of coke. The quantity of coal shipped to eastern points during 1910 amounted to 10,781,544 short tons, against 11,300,162 short tons in 1909.

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

Movement of coal to and through Pittsburgh, 1906–1910, in short tons, showing totals by rail and water.

	1906	1907	1908	1909	1910
By rail:					
To Pittsburgh district	5,107,413	4,774,977	3,494,905	4,654,249	6,139,959
To west of Pittsburgh	22,419,496	20,817,263	18,970,848	18,981,995	[a] 22,683,276
Total by rail	27,526,909	25,592,240	22,465,753	23,636,244	28,823,235
By Monongahela River locks:					
To Pittsburgh district	6,840,816	7,611,680	6,435,851	9,737,505	9,460,695
To west of Pittsburgh	2,883,965	3,204,129	1,742,339	2,463,385	1,770,305
Total by water	9,724,781	10,815,809	8,178,190	12,200,890	11,231,000
Total shipments	37,251,690	36,408,049	30,643,943	35,837,134	40,054,235

[a] Includes a small quantity of coal sent to Lake Erie points.

Movement of coal to and through Pittsburgh, 1906–1910, in short tons, showing totals to Pittsburgh district and west of Pittsburgh.

	1906	1907	1908	1909	1910
To Pittsburgh district:					
By rail	5,107,413	4,774,977	3,494,905	4,654,249	6,139,959
By water	6,840,816	7,611,680	6,435,851	9,737,505	9,460,695
Total to Pittsburgh district	11,948,229	12,386,657	9,930,756	14,391,754	15,600,654
To west of Pittsburgh:					
By rail	22,419,496	20,817,263	18,970,848	18,981,995	22,683,276
By water	2,883,965	3,204,129	1,742,339	2,463,385	1,770,305
Total to west of Pittsburgh	25,303,461	24,021,392	20,713,187	21,445,380	24,453,581
Total shipments to Pittsburgh and points west	37,251,690	36,408,049	30,643,943	35,837,134	40,054,235
Shipments, all rail, to points east of Pittsburgh	....	12,202,530	11,666,160	11,300,162	10,781,544

BUFFALO, N. Y.

Mr. John W. Chamberlin, trade press correspondent, has contributed for this report the following review of the coal trade of Buffalo:

Buffalo is the chief passing point of coal from the Pennsylvania mines northward; it covers a large eastern territory in the bituminous trade, and is the principal supply point of anthracite to the upper Lake district. Owing to the entire absence of statistics of the rail traffic, it is impossible to give this movement in anything like accurate figures. That it has been steadily increasing in late years is shown by the increase in export and water figures.

Speaking in general, it may be said that the competing routes have hardly grown in importance as fast as the total amount of coal moving northward has increased of late. These competitors consist mainly of two car ferries across Lake Erie from Conneaut and Ashtabula, Ohio, and one across Lake Ontario from Charlotte, N. Y. There has been some increase in water shipments from Lake Erie to Lake Ontario ports and the St. Lawrence Valley, but this was owing chiefly to difficulties at receiving ports on Lake Ontario, the one practically offsetting the other.

The water traffic of Buffalo in coal is confined almost entirely to anthracite, it being too far from the soft coal mines to compete with Erie, Pa., and the Ohio ports of Lake Erie. Of about 4,500,000 tons of anthracite coal shipped by lake, Buffalo ships practically three-quarters, the competitors being Erie, Pa., and Oswego, N. Y., with one or two minor ports on Lake Ontario. These various ports increase their water shipments slowly, without much variation from year to year, though in 1910 Buffalo made an increase of water shipment of about 400,000 tons, the total quantity being 3,359,644 long tons, as compared with 2,752,787 tons in 1905. These figures are furnished by the shippers and are exact.

Of the shipments in 1910, more than 3,000,000 tons went to Chicago and Milwaukee, on Lake Michigan, and to Duluth and Superior, at the head of Lake Superior, there being also more than 30 minor ports each receiving from 500 tons upward. There has been little change in the destination of this water coal in late years, since the absorption of the trade of Toledo and Detroit by the railroads. There is a steady and somewhat growing water trade between Oswego and the upper Lake district

It is estimated that Buffalo receives by rail about 4,000,000 long tons of anthracite and 5,200,000 tons of bituminous annually, and since the impetus given by the anthracite strike of 1902 it has been a leading sales center of soft coal, the principal anthracite companies conducting their own sales through direct agencies. Owing to the large and growing competition from natural gas and Niagara electric power, the city consumption of all coal increases very slowly, natural gas being the competitor chiefly of anthracite and electric power the principal competitor of bituminous coal. Recent increased use of electric power in Canadian towns has somewhat reduced sales in that territory.

The price of anthracite coal, though regulated by the companies at $5.25 for grate, $5.50 for stove and egg, and $5.75 for chestnut, is no higher than the price of a comparatively small amount of independent anthracite that reaches this port. Natural gas where available readily displaces coal. The large and growing bituminous trade is much demoralized by overproduction, and especially by the competition between the Allegheny Valley and the Pittsburgh districts, and again eastward between these and the Clearfield district. These coals all differ somewhat in appearance and quality, but are able to compete very sharply. Coal from the West Virginia district is ready to come in if the prices should be materially advanced.

The price of Pittsburgh bituminous is $2.65 for select lump, $2.50 for three-quarter, $2.40 for mine run, and about $2 for slack, with Allegheny Valley prices from 15 to 25 cents less. Clearfield coal does not enter Buffalo in quantity. The movement of coal from Buffalo is well shown by statistics of exports to Canada, which are also exact and are as follows for the last five years:

Exports of coal from Buffalo to Canada, 1906-1910, in long tons.

Year.	Anthracite.	Bituminous.	Coke.	Total.
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
1910	931,378	2,014,762	420,805	3,366,945

The bituminous coal mines owned in Buffalo are mostly in the Allegheny Valley and are increasing in number and output, especially those of the larger interests.

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 coal statistics of the chamber of commerce are made up of information representing movements of the product by river and by railroad. Arrivals by railroad are ascertained in connection with the daily work of securing reports of the movement of commodities from freight waybills of the various terminal offices in the city. The weights of cars of coal are noted to a large extent for the different lines over which such supplies are received in order to secure an acceptable basis for calculating the average weight of all cars reported, and thus of determining the equivalent in bushels, which is the adopted unit in such statistics.

Information concerning river supplies of coal is secured by reports of quantities gaged and by statements furnished by the various receivers of coal indicating quantities not gaged.

The total arrivals of coal at Cincinnati in 1910 by river and by railroad represent an aggregate of 162,011,000 bushels, or 5,849,000 tons of 2,000 pounds. This quantity has not been previously equaled in the yearly record, although closely approached in 1905. Compared with 1909 there was a gain of 26,384,000 bushels in the total arrivals; compared with the annual average of five years prior to 1910 there was an increase of 13,807,000 bushels, and compared with the average for the preceding period of five years an increase of 62,036,000 bushels.

Of the arrivals of coal in 1910 the total by river was 36,619,000 bushels and by rail 125,392,000 bushels, the comparison with 1909 showing a decrease of 9,437,000 bushels by river and an increase of 35,821,000 bushels by rail.

Shipments of coal from this market in 1910 were 4,256,000 bushels by river and 100,920,000 bushels by rail. The river shipments were 2,471,000 bushels less than for 1909 and the rail shipments showed an increase of 37,709,000 bushels. It is not practicable to undertake to determine from the available records of movement what proportion of the rail shipments represent local reshipment business and the proportion that passes through this market destined for other localities.

The price of coal afloat, from both Pittsburgh and Kanawha districts, was 8 cents per bushel until November, when it was advanced from 8.25 to 8.75 cents. The general average for the year was 8.05 cents. Run of mine coal sells at about three-fourths of a cent per bushel and nut and slack at about 2 cents under the standard price for lump.

For lump coal delivered to consumers the price for both Pittsburgh and Kanawha receipts in 1910 was mostly at $3.25 per ton until late in September, when there was an advance to $3.50, and in November, when there was a further advance to $3.75. The year's average was $3.40 per ton, compared with $3.15 for 1909 and $3.35 for five years prior to 1910. On the bushel basis the price of lump coal delivered was about 12.25 cents for 1910, compared with an annual average of 12.05 cents for five years prior to 1910 and 11½ cents for the preceding period of five years. For nut and slack coal the range for deliveries to consumers in 1910 was mainly from $1.90 to $2.10 per ton.

Anthracite coal is consumed in this market to a limited extent only, the total receipts in 1910 being 337,000 bushels, compared with 471,000 for 1909 and an annual average of 595,000 for 10 years prior to 1910. The price delivered to consumers in 1910 ranged from $6.75 to $7 per ton, averaging about $6.85.

The local consumption of coal as near as can be judged by available information appears to be about 55 per cent for industrial purposes and 45 per cent for household uses.

The aggregate local consumption of coal in the Cincinnati district appears to have averaged about 67,000,000 bushels annually for the last five years.

The local consumption of gas in 1910 represented deliveries of natural gas only, and aggregated 9,100,643,000 cubic feet, as compared with a total of 3,861,761,000 cubic feet during 1909, of which manufactured gas represented 995,511,000 cubic feet. The great increase in local consumption of gas in 1910 is accounted for in an enlarged use by industrial plants and for household purposes. The product of electric current furnished by the gas company represented a total of 37,132,765 kilowatts in 1910, as compared with 45,483,000 kilowatts for 1909.

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

Prices of Pittsburgh coal at Cincinnati, 1899–1910, in cents per bushel.

Year.	Afloat.			Delivered.		
	Lowest.	Highest.	Average.	Lowest.	Highest.	Average.
1899	4½	7½	5.30	8⅛	11¾	9.50
1900	7½	8	7.50	10¾	11¾	10.90
1901	6½	8	7.50	9	10¾	10.55
1902	6½	10	7.92	10	14½	11.75
1903	9	10	9.25	12⅝	14½	13.20
1904	8	9	8.50	10¾	13½	11.50
1905	8	8	8.00	11¾	12⅝	12.05
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
1910	8	8¾	8.05	11¾	13½	12.25

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 Pittsburgh 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 2,956,000 bushels, and the quantity locally manufactured was 1,136,000 bushels, making a total of 4,092,000 bushels, as compared with 7,657,000 bushels in 1909. For city manufacture the average price for the year was 11½ cents per bushel; of gas house, 11 cents; of Connellsville, $5.50 per ton.

The annual receipts of coal, in bushels, at Cincinnati, according to reports of gagers, private returns, and records of the chamber of commerce, for the last five years have been as follows:

Receipts of coal at Cincinnati, 1906–1910, in bushels.

Year.	By river.			By rail.		
	Pittsburgh.	Kanawha.	Other kinds.	Kanawha.	Other kinds.	Anthracite.
1906	31,118,000	23,651,000	1,970,000	64,034,000	52,392,000	792,000
1907	30,726,000	33,495,000	426,000	46,573,000	38,106,000	654,000
1908	13,397,000	21,689,000	679,000	46,209,000	37,808,000	855,000
1909	20,765,000	25,252,000	39,000	49,005,000	40,095,000	471,000
1910	12,678,000	23,765,000	176,000	68,780,000	56,275,000	337,000

The total annual receipts, by river and by rail, and aggregate receipts, with total annual shipments, by river and by rail, and aggregate shipments for the last five years are given in the following table:

Movements of coal at Cincinnati, 1906–1910, in bushels.

Year.	Receipts.		Aggregate.	Shipments.		Aggregate.
	By river.	By rail.		By river.	By rail.	
1906	56,739,000	117,218,000	173,957,000	5,833,000	93,212,000	99,045,000
1907	64,647,000	85,333,000	149,980,000	5,006,000	66,408,000	71,414,000
1908	35,765,000	84,872,000	120,637,000	3,380,000	60,854,000	64,234,000
1909	46,056,000	89,571,000	135,627,000	6,727,000	63,211,000	69,938,000
1910	36,619,000	125,392,000	162,011,000	4,256,000	100,920,000	105,176,000

CLEVELAND, OHIO.

The total coal and coke receipts at Cleveland in 1910, as reported by Mr. Munson A. Havens, secretary of the Cleveland Chamber of Commerce, aggregated 8,435,309 short tons, an increase over 1909 of 772,500 short tons. The record of 7,662,809 tons in 1909 was the maximum up to that time. The increase in 1910 was principally in the receipts of bituminous coal and was almost entirely in the coal received and reshipped, probably going to make up the shortage in supplies of Illinois coal that had been cut off by the strike in the mines of that State. The local consumption of Cleveland increased less than 3,000 tons. Anthracite receipts increased 37,263 tons, or a little over 10 per cent; receipts of coke decreased nearly 100,000 tons, from 1,034,649 tons in 1909 to 937,714 tons in 1910. The receipts of bituminous coal increased from 6,264,998 tons to 7,097,170 tons, which was offset by an increase of 681,687 tons in the shipments of bituminous coal.

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, 1906–1910, in short tons.

RECEIPTS.

Kind.	1906	1907	1908	1909	1910
Bituminous	6,021,958	5,995,197	5,715,781	6,264,998	7,097,170
Anthracite	145,822	153,077	515,717	363,162	400,425
Coke	659,307	849,850	690,742	1,034,649	937,714
	6,827,087	6,998,124	6,922,240	7,662,809	8,435,309

SHIPMENTS.

Kind.	1906	1907	1908	1909	1910
Anthracite by rail	10,138	7,553	41,428	25,383	18,020
Bituminous by rail	45,687	112,500	82,542	122,814	383,408
Bituminous by lake	2,926,279	3,264,875	3,350,830	4,602,275	5,023,368
Coke by rail	117,718	56,738	75,559	102,375	197,784
	3,099,822	3,441,666	3,550,359	4,852,847	5,622,580

Total coal receipts and shipments, with local consumption, at Cleveland, Ohio, 1906–1910, in short tons.

Year.	Receipts.	Shipments.	Local consumption.
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	4,852,847	2,809,962
1910	8,435,309	5,622,508	2,812,801

CHICAGO, ILL.

For the last two years the railroad companies entering Chicago have adopted a secretive policy in regard to the shipments of coal into that city, and no statistics of this kind are now available. Mr. F. E. Saward, in the Coal Trade, estimates the total shipments to and through Chicago (including Chicago junction points) in 1910 at 14,600,000 tons, against estimated receipts in 1909 of 14,446,000 tons. Receipts by lake were 1,001,718 tons of anthracite and 580,222 tons of bituminous coal, against 790,759 tons and 449,527 tons, respectively, in 1909.

ST. LOUIS, MO.

The Business Men's League of St. Louis, through its secretary and general manager, Mr. Wm. Flewellyn Saunders, reports an increase in 1910 of over 500,000 tons in the receipts of bituminous coal, or from 7,418,268 tons in 1909 to 7,945,680 tons in 1910, notwithstanding the strike of nearly six months' duration in the Illinois coal fields. That the trade of St. Louis was not more seriously affected may be assigned to the fact that the coal operators in the fifth and ninth districts of Illinois seceded from the Operators' Association in the latter part of May (the strike having begun April 1), acceded to the demands of the miners, and resumed operations. A large quantity of coal also came into St. Louis from Kentucky, but at higher freight rates than is exacted on the product from Illinois mines. The effect of the strike was shown more in advanced prices; for, in addition to the natural rise in price for Illinois coals incident to the shortage in supply, the miners succeeded in obtaining the higher wages demanded at the beginning of the strike. Another reason for the advanced price was the enactment by the Illinois Legislature of laws compelling operators to equip their mines with devices for preventing fires and for otherwise protecting the workmen. All of these added to the expenses of production and necessitated advanced prices for the output.

The freight rates from the Illinois coal fields to St. Louis remained stationary during the entire year—52 cents per ton from the inner group of mines and 67 cents from the Carterville district.

The receipts of coal and coke at St. Louis for the last six years and the high, low, and closing prices in 1909 and 1910 are shown in the following tables:

Coal and coke receipts at St. Louis, Mo., 1905–1910, 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	1910	7,945,680	289,463	191,190

Coal prices at St. Louis, Mo., during 1909 and 1910, in short tons.

Kind.	1909			1910		
	Highest.	Lowest.	Closing.	Highest.	Lowest.	Closing.
Standard Illinois lump coal	$1.92	$1.27	$1.92	$2.52	$1.37	$1.62
High-grade Illinois lump coal	2.37	1.67	2.37	2.92	1.97	1.97
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	6.05	5.05	6.05	5.40	5.05	5.40
New River coke	5.55	4.55	5.55	5.40	5.05	5.40
Kentucky coke	3.65	3.40	3.65	4.10	3.50	4.10
Gas coke	4.75	4.25	4.75	4.65	4.15	4.40

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:

The receipts of coal at Milwaukee in 1910, both rail and Lake, increased over those of 1909 by 885,179 tons. The total amount of coal received was 5,061,201 tons, which exceeded the largest previous year's receipts by 711,694 tons. The receipts by Lake from the lower Lake ports amounted to 4,611,332 tons, of which about 20 per cent was anthracite. The largest quantity consigned to this city from any one point was 1,311,786 tons from Toledo.

The 11 principal coal-shipping ports of the Great Lakes cleared 21,313,295 short tons of coal, and of this total quantity Milwaukee received 21.6 per cent, and her proportion of the hard-coal shipments from these ports was 22 per cent.

Receipts by car-ferry lines across Lake Michigan from Ludington and Grand Haven, by the Pere Marquette and Grand Trunk railways, respectively, amounted to 327,415 tons, and the rail lines, the Chicago, Milwaukee & St. Paul, the Chicago and North Western, and the Soo Line, brought in 122,454 tons.

The largest cargo arriving at this port during the 1910 season of navigation was the steamer *Salt Lake City*, laden with 11,250 tons of bituminous coal. Seventy-nine vessels reporting at Milwaukee carried cargoes of 10,000 tons each or over.

The rates of freight on coal by Lake for the 1910 season were not materially different from the prevailing quotations of the season of 1909.

The distribution of coal from this point, also, was on a considerably larger scale than ever before. The rail shipments from Milwaukee amounted to 1,689,135 tons.

The rail transportation situation was very much more favorable than during the winter of 1909, and coal shipments to the interior went forward without unusual delay.

The price of anthracite remained at about the same figure as for 1909, but the price of bituminous coal was increased an average of 25 cents per ton.

The following table shows the receipts of coal at the four principal upper Lake ports during the last three years. Superior has drawn considerably ahead in 1910, but it must be remembered that by far the larger part of the coal received at Superior is for transshipment to other points in the Northwestern States and that two-thirds of the receipts at Milwaukee are consumed locally. Milwaukee's gain in 1910 over 1909 was quite satisfactory.

Coal received by Lake, 1908–1910, in short tons.

	1908	1909	1910
Superior	4,207,823	4,052,735	6,204,328
Milwaukee	3,810,596	4,040,436	4,932,262
Duluth	1,705,869	1,590,106	2,229,865
Chicago and South Chicago	1,577,179	1,282,281	1,606,282

The receipts of coal 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., 1905–1910, in short tons.

Source.	1905	1906	1907	1908	1909	1910
By Lake from—						
Buffalo	800,814	748,644	813,904	1,005,594	778,392	810,409
Erie	60,641	66,964	140,313	17,359	80,980	82,072
Oswego	4,369	8,002	28,428	58,285	56,588	68,983
Cleveland	247,878	560,475	740,785	520,244	382,828	436,057
Ashtabula	245,455	263,527	318,046	167,851	212,314	520,376
Lorain	159,788	157,515	204,873	337,465	610,444	671,656
Sandusky	359,427	362,408	457,582	451,807	393,869	388,467
Toledo	770,962	851,521	1,064,666	891,626	1,057,076	1,311,786
Fairport	23,051	25,627	50,041	77,001	108,210	61,737
Huron, Ohio	87,008	160,274	134,508	22,425	26,015	86,046
Other ports	75,739	149,115	88,366	111,510	115,358	173,743
Total, Lake	2,835,132	3,354,072	4,039,512	3,661,167	3,822,074	4,611,332
By railroad	[a] 322,332	[b] 461,203	[c] 309,995	[d] 380,759	[e] 353,948	[f] 449,869
Receipts	3,157,464	3,815,275	4,349,507	4,041,926	4,176,022	5,061,201

[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.
[f] Including 327,415 tons by car ferry.

Shipments of coal from Milwaukee, Wis., 1905–1910, in short tons.

Shipped by—	1905	1906	1907	1908	1909	1910
Chicago, Milwaukee & St. Paul Ry	668,509	631,205	698,040	632,184	776,010	1,019,330
Chicago & North Western Ry	512,536	459,333	509,271	471,101	483,250	530,010
Wisconsin Central Ry.[a]	87,105	93,766	103,551	99,411	123,500	139,435
Lake	9,460	4,138	....	....	....	360
	1,277,610	1,188,442	1,310,862	1,202,696	1,382,760	1,689,135

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

Total receipts of coal by Lake from lower Lake ports at Milwaukee, Wis., 1905–1910, by kinds, in short tons.

Kind.	1905	1906	1907	1908	1909	1910
Anthracite	802,083	756,646	858,402	1,063,879	834,980	930,472
Bituminous	2,033,049	2,597,426	3,181,110	2,597,288	2,987,094	3,680,860
	2,835,132	3,354,072	4,039,512	3,661,167	3,822,074	4,611,332

Receipts of coal at Milwaukee, Wis., by Lake and rail in 1865, 1870, 1880, 1890, and annually from 1900 to 1910, in short tons.

1865	36,369	1904	2,944,439
1870	122,865	1905	3,157,464
1880	368,568	1906	3,815,275
1890	999,657	1907	4,349,507
1900	1,808,593	1908	4,041,926
1901	1,953,489	1909	4,176,022
1902	1,641,095	1910	5,061,201
1903	3,023,977		

Lake freights on coal from Buffalo to principal upper Lake ports during the season of 1910, as compared with those of 1909, were as follows:

Freight rates per ton on coal from Buffalo to principal upper Lake ports, 1909 and 1910, by months.

Month.	To Milwaukee.		To Chicago. North Branch.		To Chicago. South Branch.		To Duluth.	
	1910	1909	1910	1909	1910	1909	1910	1909
March	$0.35	$0.35	$0.40	$0.40	$0.45	$0.45	$0.30	$0.30
April	.35	.35	.40	.40	.45	.45	.30	.30
May	.35	.35	.40	.40	.45	.45	.30	.30
June	.35	.35	.40	.40	.45	.45	.30	.30
July	.35	.35	.40	.40	.40	.45	.30	.30
August	.35	.35	.40	.40	.40	.45	.30	.30
September	.35	.35	.40	.40	.40	.45	.30	.30
October	.35	.35	.40	.40	.40	.45	.30	.30
November	.35	.35	.40	.40	.40	.45	.30	.30
December	.50	.75 to 1.00	.50	.75	.30	.75	.50	.75

THE PACIFIC COAST.

The fuel requirements of the Pacific coast and the methods of meeting them are of special interest at the present time because of the agitation in regard to the development or nondevelopment of the coal resources of the Territory of Alaska. The consumption of coal on the Pacific coast and the markets available for Alaskan coal have been discussed by Alfred H. Brooks, in charge of the division of Mineral Resources of Alaska,[1] but one factor bearing upon this important subject has not been sufficiently emphasized in the public press, and that is that any fuel brought into competition with those which now supply the markets must, in order to secure a footing, be cheaper or better than the fuel sought to be displaced. Another factor to be considered is that the present consumption of coal on the Pacific coast is not large and the successful operation of any coal mines in Alaska will depend upon making prices attractive to the development of manufacturing industries. For railroad and manufacturing purposes the consumption of oil, particularly in California, largely exceeds that of coal; in fact, for railroad use oil is practically the only fuel. The principal domestic fuels are wood and gas made from oil. Recently oil itself has assumed importance as a domestic fuel. About 15,000,000 barrels of California oil were consumed by locomotives in 1909. In 1910 the locomotive consumption was a little over 18,000,000 barrels. The total consumption of fuel oil was probably between 35,000,000 and 40,000,000 barrels in 1909 and between 40,000,000 and 50,000,000 barrels in 1910. These figures do not include the oil made into gas, but they do include a considerable quantity of oil from which the lighter oils have been distilled leaving a residue suitable for fuel purposes. Mr. Brooks in his report, already referred to, estimated for 1909 about 12,000,000 tons of coal displaced by the use of California oil for fuel. Mr. Brooks, however, bases his estimate on 3 barrels of oil being equivalent to 1 ton of

[1] Brooks, A. H., Alaska coal and its utilization: Bull. U. S. Geol. Survey, No. 442, 1910, pp. 48–100.

coal, whereas in practice it has been found that it requires about 3½ barrels of oil to do the work of 1 ton of coal. The probability is that the consumption of fuel oil displaced about 10,000,000 tons of coal on the Pacific coast in 1909 and between 11,000,000 and 12,000,000 tons in 1910. The per capita consumption of coal in California, Oregon, and Washington averages not much over 1 ton, while the average consumption in the United States as a whole is about 5¼ tons for each inhabitant. The consumption of fuel oil for each inhabitant on the Pacific coast is equivalent to 2½ to 3 tons of coal.

The principal source of coal supply for the Pacific coast is the State of Washington, the output of both California and Oregon being at present negligible. In 1909 the total production of coal in Washington was 3,602,263 short tons. California produced 45,000 tons, and Oregon, 87,276 tons. The receipts of eastern coal by water at San Francisco amounted to 76,081 tons. The imports of bituminous coal into all Pacific coast ports (chiefly from British Columbia) amounted to 573,834 tons, and the imports of anthracite (chiefly from China) amounted to 3,481 tons. About 15,000 tons of Wyoming coal are used in Portland annually, and about 200,000 tons of Rocky Mountain coal are shipped each year into California. In 1910 the production of coal on the Pacific coast was 3,911,899 short tons in Washington, 67,533 tons in Oregon, and 11,164 tons in California. The imports of bituminous coal amounted to 752,046 tons, and of anthracite, to 9,116 tons. The receipts by rail from the Rocky Mountain States were estimated at 220,000 tons, and 97,153 tons were received from eastern points. The exports of coal from Seattle were in 1909, 26,883 tons, and in 1910, 23,771 tons. From these figures it appears that the total consumption of coal on the Pacific coast in 1909 (deducting the exports at Seattle) was 4,576,052 short tons, and in 1910, 4,812,398 tons. The imports of coke to Pacific coast ports (exclusive of Hawaii), as reported by the Bureau of Statistics of the Department of Commerce and Labor, were 111,676 short tons in 1909 and 114,061 tons in 1910.

The consumption is estimated to be distributed as follows:

Estimated consumption of coal on the Pacific coast in 1910, in short tons.

By railroads	1,500,000
By bunker trade	650,000
By factories, etc., on Puget Sound	1,000,000
By domestic trade at San Francisco and vicinity	500,000
By domestic trade at Portland	60,000
In Alaska	100,000
Total	3,810,000

This leaves from 750,000 to 1,000,000 tons as representing the coal consumption in the Pacific coast States, outside of San Francisco, Portland, and Puget Sound. It is peculiarly unfortunate, in view of the widespread interest in the possible influence that the Alaskan coals might have on the industrial development of the Pacific coast, that there are no local bureaus in either of the three cities by which accurate statistical data are compiled. The following figures were gathered in the main by the writer during a recent visit to the Pacific coast:

Mr. N. Poston, manager of the Pacific Coast Coal Co.'s office in San Francisco, furnished the writer the following information showing the companies which received coal in San Francisco during 1910, and the sources from which it came:

Coal receipts by water at San Francisco in 1910, in short tons.

Name of company.	Receipts.	Source.
Western Fuel Co	249,707	Vancouver Island, British Columbia.
Pacific Coast Coal Co	162,182	Washington and Australia.
Hind, Rolph & Co	29,500	Australia.
J. J. Moore & Co	21,651	Do.
Pacific Fuel Co	3,690	Beaver Hill, Oreg.
Anthracite Coal Corporation	5,896	Pennsylvania and China.
Cumberland Coal Co	3,365	Cumberland, Md.
Java & Asiatic Co	5,613	China.
Direct Transportation Co	403	Bandon, Oreg.
United States Government	77,937	Pocahontas, W. Va.
Total	559,944	

The following statement of the receipts of coal at San Francisco in 1909 and 1910, prepared by Mr. T. C. Friedlander, secretary of the Merchant's Exchange, shows some difference in the figures for 1910, as prepared by Mr. Poston, and is probably due to a difference in time of taking the figures, one report being taken on arrival, and the other on unloading:

Coal imports at Pacific coast ports, 1909 and 1910, in short tons.

From—	Foreign.		From—	Domestic.	
	1909	1910		1909	1910
British Columbia	200,689	186,416	Washington	28,624	72 895
Australia	108,955	173,155	Oregon	27,406	15,201
Great Britain		2,872	Domestic eastern	85,211	97,153
Japan	6	43,766			
China		6,911			
Total	309,650	413,120	Total	141,241	185,249

Grand total, 1909	450,891
Grand total, 1910	598,369

Mr. G. W. Hill, harbor master at the port of Seattle, is the authority for the following statement showing the receipts and shipments at that port in 1909 and 1910:

Imports and exports of coal, Seattle, Wash., 1909 and 1910, in short tons.

	1909	1910
SHIPMENTS.		
To coastwise points	316,519	552,896
To Bering Sea points	6,250	761
To Hawaii		144
To southeastern Alaska	19,996	15,877
To Puget Sound points		67,153
To British Columbia	280	637
To South America	357	6,496
Total	343,402	643,964
RECEIPTS.		
From British Columbia	53,403	57,669
From Australia	6,657	3,333
From Baltimore		5,087
Total	60,060	66,089

Mr. J. B. Clift, harbor master at Tacoma, Wash., reports the bunker shipments of coal from that port at 59,839 long tons in 1909, and at 46,829 tons in 1910. The receipts of coal by water for the two years were, respectively, 4,550 long tons and 5,500 long tons.

According to the Bureau of Statistics, Department of Commerce and Labor, the imports of foreign coal into Pacific coast ports during the calendar year 1910 were 679,609 long tons, or 761,162 short tons, against 515,460 long tons, or 577,315 short tons, in 1909. The ports receiving this coal and the countries from which it was exported are shown in the following table:

Imports of coal into Pacific ports during the calendar year 1910, in long tons.

District and country.	Anthracite.		Bituminous.	
	Quantity.	Value.	Quantity.	Value.
Alaska: Canada			73,020	$353,348
Astoria (Oreg.):				
Canada			3,804	16,530
Australia and Tasmania			8,728	23,364
Total			12,532	39,894
Hawaii:				
England			3,431	13,634
Australia and Tasmania			59,481	152,730
Japan			15,052	49,666
Total			77,964	216,030
Humboldt:				
Canada			1,091	4,364
Australia and Tasmania			953	3,029
Total			2,044	7,393
Los Angeles:				
Canada			200	850
Chinese Empire	137	$696	1,586	4,551
Total	137	696	1,786	5,401
Portland (Willamette):				
England	1,973	7,797		
Australia and Tasmania			14,750	39,503
Japan			3	13
Total	1,973	7,797	14,753	39,516
Puget Sound:				
Canada			93,567	387,941
Australia and Tasmania			2,976	7,965
Total			96,543	395,906
San Diego: Canada			29,142	116,568
San Francisco:				
England	2,564	9,738		
Canada			165,158	645,679
Mexico			52	153
Chinese Empire	3,465	23,674	2,995	7,485
Australia and Tasmania			154,001	409,673
Straits Settlements			275	1,100
Japan			41,205	125,752
Total	6,029	33,412	363,686	1,189,842

The Bureau of Statistics also reports the following as the coastwise coal receipts at the principal Pacific coast ports during 1909 and 1910:

Coastwise coal receipts at principal Pacific ports during the calendar years 1909 and 1910.

	1909	1910
San Francisco.....long tons..	[a] 230,514	[b] 285,484
Portland, Oreg.....short tons..	5,100	5,301
Seattle, Wash. (from Baltimore).....long tons..	....	4,542

[a] Includes 76,081 long tons from the Eastern States.
[b] Includes 186,598 long tons from the Eastern States.

Mr. Edmond C. Giltner, secretary of the Portland Chamber of Commerce, in a letter to the writer states that the quantity of coal brought into Portland by rail in 1910 was 68,835 long tons. Distributed by railroads, this tonnage was as follows:

Receipts of coal from railroads at Portland, Oreg., in 1910.

Northern Pacific Railway.....long tons..	35,411
Oregon Railroad & Navigation Co.....do....	30,267
Southern Pacific Railway.....do....	3,157

Including 761 short tons of coal sent from Puget Sound to Bering Sea, the total quantity of coal shipped into Alaska in 1910 was 98,420 short tons, of which 8,178 tons were from British Columbia and 15,877 tons were from Washington. The production within the Territory was reported at 1,000 tons, or about 1 per cent of the total consumption.

The following table, compiled by the Bureau of Statistics of the Department of Commerce and Labor, gives the imports of coke into Pacific coast ports in 1909 and 1910:

Imports of coke into the Pacific ports during the calendar years 1909 and 1910, in long tons.

Port.	1909		1910	
	Quantity.	Value.	Quantity.	Value.
Alaska	30	$210	....	....
Hawaii	350	1,474	851	$3,107
Los Angeles, Cal	1,842	6,327	2,597	8,413
Portland, Oreg	2,365	9,135	4,021	14,187
Puget Sound, Wash	384	1,596	2,121	8,603
San Diego, Cal	3,193	11,039	2,824	9,565
San Francisco, Cal	91,897	349,178	90,277	310,439
Total	100,061	378,959	102,691	354,314

PRODUCTION OF COAL BY STATES AND TERRITORIES.

GEOGRAPHIC DIVISIONS.

Twenty-nine States and Territories produced coal in commercial quantities in the United States in 1910, the same number as in 1909. Of these 29 States and Territories, 12 are east of Mississippi River and 17 west of that boundary. The 12 States east of Mississippi River produced in 1910 446,471,005 short tons, or 89 per cent of the total, whereas the 17 States west of Mississippi River produced 55,125,373 short tons, or 11 per cent. This was a slight increase in the percentage of the total for the Eastern States and a decrease for the Western States, as in 1909 the States east of the Mississippi produced 406,084,885 short tons, or 88.1 per cent of the total, and the Western States produced 54,718,531 short tons, or 11.9 per cent. In 1908 the percentages were, respectively, 88.3 and 11.7. Owing to the natural geographic position of the States east of Mississippi River, as made by the boundary line formed by Ohio and Potomac rivers, 6 of the coal-producing States east of the Mississippi lie north of the Ohio and the Potomac and 6 are to the south. The 6 Northern States are Pennsylvania, Maryland, Ohio, Illinois, Indiana, and Michigan. These States in 1910 produced 340,258,583 short tons, or 67.8 per cent of the total; in 1909 they produced 318,523,973 short tons. The 6 Southern States are Virginia, West Virginia, Alabama, Georgia, Tennessee, and Kentucky. These States in 1910 produced 106,212,422 short tons, or 21.2 per cent of the total; in 1909 these States produced 87,572,112 short tons, or 19 per cent of the total. From this it appears that the relative gain made in 1910 in the Eastern States was entirely in the Southern States, the proportion of the total contributed by the Northern States decreasing from 69.1 to 67.8 per cent, while the percentage of the Southern States increased from 19 to 21.2. The relative progress made by the Southern States in 30 years shows even more remarkable growth. In 1880 the Northern States produced 63,044,558 short tons, and the production in 1910 was about 5.4 times that of 1880; the Western States produced in 1910 about 12 times the 1880 output of 4,705,271 short tons; and the production of the Southern States in 1910, of 106,212,422 short tons, was nearly 30 times the 3,793,308 tons produced in 1880.

The productions of the various States, grouped according to the geographic divisions made by the Mississippi, the Ohio, and the Potomac, for the years 1880, 1890, 1900, 1909, and 1910, are shown in the following table:

Coal production in States north of Ohio and Potomac rivers in 1880, 1890, 1900, 1909, and 1910, 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

Coal production in States north of Ohio and Potomac rivers in 1880, 1890, 1900, 1909, and 1910, in short tons—Continued.

State.	1909		1910	
	Quantity.	Value.	Quantity.	Value.
Illinois	50,904,990	$53,522,014	45,900,246	$52,405,897
Indiana	14,834,259	15,154,681	18,389,815	20,813,659
Maryland	4,023,241	4,471,731	5,217,125	5,835,058
Michigan	1,784,692	3,199,351	1,534,967	2,930,771
Ohio	27,939,641	27,789,010	34,209,668	35,932,288
Pennsylvania:				
Anthracite	81,070,359	149,181,587	84,485,236	160,275,302
Bituminous	137,966,791	130,085,237	150,521,526	153,029,510
Total	318,523,973	383,403,611	340,258,583	431,222,485

Coal production in States south of Ohio and Potomac rivers in 1880, 1890, 1900, 1909, and 1910, 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.	1909		1910	
	Quantity.	Value.	Quantity.	Value.
Alabama	13,703,450	$16,306,236	16,111,462	$20,236,853
Georgia	211,196	298,792	177,245	259,122
Kentucky	10,697,384	10,079,917	14,623,319	14,405,887
Tennessee	6,358,645	6,920,564	7,121,380	7,925,350
Virginia	4,752,217	4,251,056	6,507,997	5,877,486
West Virginia	51,849,220	44,661,716	61,671,019	56,665,061
Total	87,572,112	82,518,281	106,212,422	105,369,759

Coal production in States and Territories west of Mississippi River in 1880, 1890, 1900, 1909, and 1910, 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, 1909, and 1910, in short tons—Continued.

State or Territory.	1909		1910	
	Quantity.	Value.	Quantity.	Value.
Arkansas	2,377,157	$3,523,139	1,905,958	$2,979,213
California	[a] 48,636	107,342	[a] 12,164	33,336
Colorado	10,716,936	14,296,012	11,973,736	17,026,934
Idaho	4,553	19,459	4,448	17,426
Iowa	7,757,762	12,793,628	7,928,120	13,903,913
Kansas	6,986,478	10,083,384	4,921,451	7,914,709
Missouri	3,756,530	6,183,626	2,982,433	5,328,285
Montana	2,553,940	5,036,942	2,920,970	5,329,322
New Mexico	2,801,128	3,619,744	3,508,321	4,877,151
North Dakota	422,047	645,142	399,041	595,139
Oklahoma (Indian Territory)	3,119,377	6,253,367	2,646,226	5,867,947
Oregon	87,276	235,085	67,533	235,229
Texas	1,824,440	3,141,945	1,892,176	3,160,965
Utah	2,266,899	3,751,810	2,517,809	4,224,556
Washington	3,602,263	9,158,999	3,911,899	9,764,465
Wyoming	6,393,109	9,896,848	7,533,088	11,706,187
Total	54,718,531	88,746,472	55,125,373	92,964,777

[a] Includes Alaska.

INDIVIDUAL STATES AND TERRITORIES.

The production of coal in the several States and Territories in 1910 and preceding years is discussed more in detail in the following pages:

ALABAMA.

Total production in 1910, 16,111,462 short tons; spot value, $20,236,853.

In a preliminary review of the coal-mining industry in 1910, published as a press bulletin early in January, 1911, it was stated that Alabama's production had reached the unprecedented total of 15,000,000 short tons. Complete returns from all but a few mines whose aggregate output is less than 50,000 tons show that the preliminary figures were exceeded by a million tons, the output being 16,111,462 short tons. This unusually large tonnage (the largest previous production being 14,250,454 short tons in 1907) was due primarily to the strike in Illinois and other Western States, and secondarily to low water in Ohio and Kanawha rivers, which reduced shipments from Pennsylvania and West Virginia to Mississippi River points. The demand thus created for Alabama coal made up for the dullness in the iron market. This dullness was pronounced during almost the entire year and was still decidedly noticeable at the close of the year, with promise of continuation during 1911.

Compared with 1909, when the production amounted to 13,703,450 short tons, the output in 1910 showed an increase of 2,408,012 short tons, or 17.57 per cent. The conditions in 1910 naturally resulted in an advance in prices, and the total value increased from $16,306,236 to $20,236,853, a gain of $3,930,617, or 24.10 per cent. The average price per ton in 1910 was $1.26, against $1.19 in 1909.

The coal mines of Alabama were practically free from strikes in 1910, there being only 25 men idle from that cause during the year. The average time lost by the 25 men was 50 days. The labor supply, although short in places, was, on the whole, satisfactory. In some parts of the State the car supply was reported the best in several years, but in other sections quite the reverse was reported.

The coal-mining industry of Alabama was marred during 1910 by two bad disasters which together cost the lives of 131 men. The first occurred on April 20 at the Mulga mine and cost 40 lives; the second was at the Palos mine, on May 5, and cost 91 lives. The number of fatalities in these two accidents was more than the total number of deaths from all causes in either 1908 or 1909. According to the report of the chief mine inspector of the State, the total number of fatal accidents in 1910 was 238, against 129 in 1909 and 108 in 1908. The death rate per thousand in 1910 was 10.7 and the number of tons mined for each life lost was 67,695; in 1909 the death rate was 6.4 and there were 106,228 tons mined for each life lost.

The number of men employed in the coal mines of Alabama in 1910 was 22,230, who worked an average of 249 days, chiefly of 10 hours. The average production per man was 725 short tons for the year and 2.91 tons for each working day.

The number of mining machines reported in 1910 was 317, and the quantity of machine-mined coal was 2,980,122 short tons, or 18.50 per cent of the total. In 1909, 283 machines were used in the production of 2,203,619 tons, or 15.02 per cent of the total. There were 6,772,860 short tons of coal washed in 1910, yielding 5,971,305 tons of cleaned coal and 801,555 tons of refuse.

The statistics of coal production in Alabama in 1909 and 1910, with the distribution of the product for consumption, are shown in the following table:

Coal production of Alabama in 1909 and 1910, by counties, in short tons.

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.

Coal production of Alabama in 1909 and 1910, by counties, in short tons—Continued.

1910.

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	1,462,720	6,961	110,883	....	1,580,564	$2,370,919	$1.50	261	2,666
Etowah	169,251	1,538	1,676	....	172,465	254,798	1.48	251	388
Jefferson	4,289,536	109,377	329,777	3,570,012	8,298,702	10,247,456	1.23	255	10,832
St. Clair	411,247	2,398	14,764	....	428,409	571,675	1.33	234	524
Shelby	450,324	3,381	34,436	....	488,141	780,887	1.60	253	847
Tuscaloosa	412,144	6,842	54,498	607,735	1,081,219	1,232,495	1.14	264	1,496
Walker	3,395,104	66,561	87,118	239,696	3,788,479	4,395,910	1.16	227	4,889
Winston	16,192	250	....	....	16,442	25,370	1.54	156	57
Other counties a	237,293	8,583	10,855	....	256,731	356,723	1.39	241	531
Small mines	....	310	....	....	310	620	2.00	......	......
Total	10,843,811	206,201	644,007	4,417,443	16,111,462	20,236,853	1.26	249	22,230

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 increases and decreases in 1910 as compared with 1909:

Coal production of Alabama, 1906–1910, by counties, in short tons.

County.	1906	1907	1908	1909	1910	Increase (+) or decrease (−), 1910.
Bibb	1,324,656	1,297,158	1,166,548	1,338,243	1,580,564	+ 242,321
Blount, Cullman	a 337,848	336,308	181,062	186,261	235,456	+ 49,195
Etowah	133,660	205,015	8,880	46,194	172,465	+ 126,271
Jefferson	6,623,115	7,526,275	5,914,129	7,176,922	8,298,702	+1,121,780
St. Clair	256,227	283,806	193,434	354,005	428,409	+ 74,404
Shelby	225,087	245,087	407,547	524,925	488,141	− 36,784
Tuscaloosa	1,050,792	1,047,364	712,101	1,006,989	1,081,219	+ 74,230
Walker	3,062,518	3,254,919	2,941,836	2,973,776	3,788,479	+ 814,703
Winston	27,076	35,333	28,408	32,278	16,442	− 15,836
Other counties and small mines	66,984	19,189	50,648	63,857	21,585	− 42,272
Total	13,107,963	14,250,454	11,604,593	13,703,450	16,111,462	+2,408,012
Total value	$17,514,786	$18,405,468	$14,647,891	$16,306,236	$20,236,853	+$3,930,617

a Includes production of Marion County.

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 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 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 16,111,462 tons in 1910.

The statistics of production in Alabama from 1840 to the close of 1910 are found in the following table:

Production of coal in Alabama from 1840 to 1910, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1840	946	1859	9,000	1878	224,000	1897	5,893,770
1841	1,000	1860	10,200	1879	280,000	1898	6,535,283
1842	1,000	1861	10,000	1880	323,972	1899	7,593,416
1843	1,200	1862	12,500	1881	420,000	1900	8,394,275
1844	1,200	1863	15,000	1882	896,000	1901	9,099,052
1845	1,500	1864	15,000	1883	1,568,000	1902	10,354,570
1846	1,500	1865	12,000	1884	2,240,000	1903	11,654,324
1847	2,000	1866	12,000	1885	2,492,000	1904	11,262,046
1848	2,000	1867	10,000	1886	1,800,000	1905	11,866,069
1849	2,500	1868	10,000	1887	1,950,000	1906	13,107,963
1850	2,500	1869	10,000	1888	2,900,000	1907	14,250,454
1851	3,000	1870	11,000	1899	3,572,983	1908	11,604,593
1852	3,000	1871	15,000	1890	4,090,409	1909	13,703,450
1853	4,000	1872	16,800	1891	4,759,781	1910	16,111,462
1854	4,500	1873	44,800	1892	5,529,312		
1855	6,000	1874	50,400	1893	5,136,935	Total	206,153,815
1856	6,800	1875	67,200	1894	4,397,178		
1857	8,000	1876	112,000	1895	5,693,775		
1858	8,500	1877	196,000	1896	5,748,697		

THE COAL FIELDS OF ALABAMA.

The Alabama coal fields (Pl. I) form the southwestern end of the great Appalachian coal region, which extends from northern Pennsylvania to central Alabama. The coal-bearing formations narrow in Tennessee, but widen abruptly in northern Alabama and cover about 6,000 square miles in the northern half of the State. There are four distinct coal-producing basins in the State, the Coosa and the Cahaba basins and the Warrior and the Plateau fields. The first three areas mentioned derive their names from the rivers which drain them. The Plateau field includes Blount, Lookout, and Sand or Raccoon mountains.

The Coosa basin is a deep syncline forming the southeast margin of the Alabama coal fields and extending across Shelby and St. Clair counties. It is 60 miles long by 6 miles wide and contains about 350 square miles. This basin has not been thoroughly explored and the number and extent of its coal beds are not well known, but in different parts 2 to 12 beds are reported having a thickness of 3 feet or more.

The Cahaba basin is also a syncline west of the Coosa basin, to which it is parallel and from which it is separated by a faulted anticline. It includes parts of St. Clair, Jefferson, Shelby, and Bibb counties. Its length is 68 miles, its average width about 6 miles, and its area 394 square miles. There are many workable beds, and the total quantity of coal in the basin is large.

COAL FIELDS OF TENNESSEE, GEORGIA, AND ALABAMA

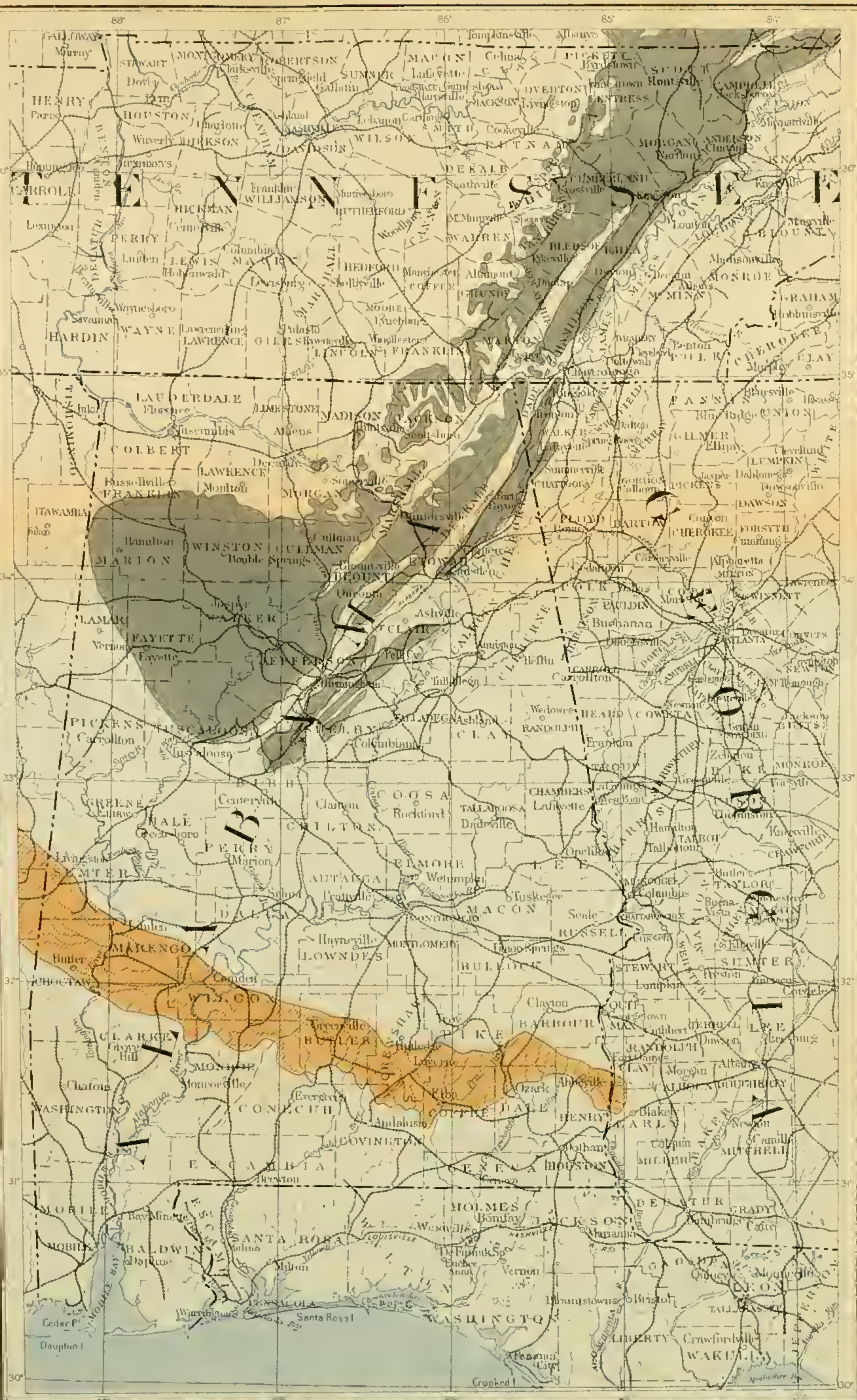
Scale $\frac{1}{2500000}$

25 0 25 50 75 100 Miles

1911

Bituminous coal fields

Lignite areas



COAL FIELDS OF TENNESSEE, GEORGIA, AND ALABAMA

Scale 1:2,500,000

25 0 25 50 75 100 Miles

1911

Bituminous coal fields

Lignite areas

The Warrior basin is separated from the Cahaba basin and Blount Mountain by Jones and Murphrees valleys. It includes all of Walker County, most of Jefferson, Tuscaloosa, and Fayette counties, and smaller parts of Blount, Cullman, Winston, and Marion counties. Its known area is estimated at 4,000 square miles. Around its western and southern margin, however, the higher rocks and coal beds pass under rocks of much later age, and have probably a considerable, and possibly a great, extent to the southwest of their visible margin. For sections showing the number and geologic relations of the coal beds of the different fields see the publications listed below.

The Warrior basin has always been the scene of the greatest mining activity and production in the State. Somewhat over one-third of the total production in the Birmingham district comes from the Pratt bed, and one-fourth comes from the Mary Lee bed. Eight or ten other beds furnish the remainder of the production.

The Plateau field embraces parts of Blount, Etowah, Dekalb, Cherokee, Marshall, and Jackson counties, and is upward of 3,000 square miles in extent. The Plateau and the Warrior fields are the southwest extension of the Cumberland plateau in Tennessee. The coal resources of the Plateau field are not well known, but they are comparatively small. There are believed to be from 4 to 6 beds that are locally workable.

From a productive point of view the most important of the coal beds in Alabama are the Pratt and the Mary Lee. These two beds, with the Blue Creek, furnish the coking coals which have made Alabama one of the important iron-making States. The Pratt bed is worked in Jefferson and Walker counties, and from it 3,931,248 short tons of coal were produced in 1909, and 4,493,451 tons in 1910. The Mary Lee also is worked in Jefferson and Walker counties, and the output from this bed amounted in 1909 to 3,276,167 short tons. In 1910 the production was 3,734,049 tons. The other beds which make important contributions to the coal production of Alabama are (1) the Blue Creek, worked in Jefferson and Tuscaloosa counties, with a production in 1909 of 798,879 short tons, and in 1910 of 1,135,849 tons; (2) the Thompson, worked in Bibb and Shelby counties, whose production amounted to 678,478 short tons in 1909, and 1,330,457 tons in 1910; (3) the Black Creek, one of the most extensive beds in the State, worked in Blount, Cullman, Jefferson, Marion, Walker, and Winston counties, produced 676,908 short tons in 1909, and 766,923 tons in 1910; (4) the Brookwood, including the Milldale, worked in Tuscaloosa County, had a production in 1909 amounting to 674,661 short tons, and in 1910 to 578,453 tons; (5) the Corona, worked in Walker County, produced 514,774 short tons in 1909, and 524,046 tons in 1910; (6) the Jagger, worked in Walker County, had an output of 507,032 short tons in 1909, and 778,486 tons in 1910; and (7) the American, worked in Jefferson and Walker counties, which in 1909 produced 272,717 short tons, and in 1910, 297,486 tons.

The other beds to which more or less local names have been given are the Buck (Clark, Blockton, No. 1, Woodstock), Cliff, Climax, Coal City, Black Shale (Gholson), Gould, Harkness, Helena, Howard, Jefferson, Mammoth, Maylene, Montevallo, Mount Carmel, Natural Bridge, Nickel Plate, Number One, Rutilia, Warrior, and Coke (Youngblood), with a few others. Some of these are probably duplicates, two names having been applied to the same bed, but they have not been correlated.

The statistics of coal production in Alabama from 1840 are found in the table on a preceding page, giving the statistical history of coal mining in the United States from the time of earliest recorded mining to the close of 1910.

According to the estimates prepared by Marius R. Campbell, of the United States Geological Survey, the original coal supply of Alabama when mining began was 68,903,000,000 short tons, of which 63,513,-000,000 tons were in the Warrior and Plateau fields, 2,994,000,000 tons were in the Cahaba field, and 2,396,000,000 tons in the Coosa field. From this total supply of approximately 69,000,000,000 tons there had been mined at the close of 1910, 206,153,815 tons, representing an exhaustion, including waste in mining, of 309,000,000 tons, or 0.4 per cent of the total estimated supply. A more recent estimate for the Coosa field by Wm. F. Prouty, assistant to the State geologist, is 80,921,000 tons; and by Chas. Butts, of the United States Geological Survey, for the Cahaba field, is 3,200,000,000 tons.

The production of coal in Alabama in 1910 was 7.8 per cent of the total production up to the close of the year, and 0.02 of 1 per cent of the estimated original supply.

Below is a list of the more important publications on the Alabama coal fields:

BIBLIOGRAPHY OF THE ALABAMA COAL FIELDS.

Butts, Charles, The Warrior coal field in the Brookwood quadrangle: Bull. U. S. Geol. Survey No. 260, 1905, pp. 357–381.

——— The Warrior coal basin in the Birmingham quadrangle, Alabama: Bull. U. S. Geol. Survey No. 285, 1906, pp. 211–222.

——— The northern part of the Cahaba coal field, Alabama, with map and sections: Bull. U. S. Geol. Survey No. 316, 1907, pp. 76–115.

——— Coking coal beds of the Warrior field, Alabama, with sections: Bull. U. S. Geol. Survey No. 400, 1910, pp. 170–189.

——— The southern part of the Cahaba coal field, Alabama, with map and sections: Bull. U. S. Geol. Survey No. 341–b, 1911, pp. 5–62.

——— Birmingham folio (No. 175), Geol. Atlas U. S., U. S. Geol. Survey, in preparation.

Gibson, A. M., Report on the Coosa coal field: Alabama Geol. Survey, 1895.

——— Report on the coal measures of the Plateau region of Alabama, including a report on the coal measures of Blount County: Alabama Geol. Survey, 1891.

Hayes, C. W., The Southern Appalachian coal field: Twenty-second Ann. Rept. U. S. Geol. Survey, 1902, pp. 227–262.

McCalley, Henry, On the Warrior coal field: Alabama Geol. Survey, 1886.

——— Report on the Warrior coal basin, with map: Alabama Geol. Survey, 1900.

Prouty, William F., The Coosa coal field of Alabama, with map and sections: Eng. and Min. Jour., Nov. 6, 1909.

Squire, Joseph, Report on the Cahaba coal field, with map: Alabama Geol. Survey, 1890.

ALASKA.

The total production of coal in Alaska in 1910 as reported to the United States Geological Survey was 1,000 short tons, valued at $15,000, the value being based probably on what consumers are obliged to pay for coal brought into the Territory. The conditions affecting the development of Alaskan coal deposits, the possible markets, and the competition with other fuels to be met have been fully discussed by Alfred H. Brooks in Bulletin No. 442 of the United States Geological Survey. Mr. Brooks's discussion of the situation leaves nothing to be added in this report, except to call attention to the insignificance of the production. The entire output of the Territory since its acquisition from Russia has been less than 50,000 short tons. The quantity brought in from British Columbia and other sources every year more than doubles the total output of the Territory since 1867.

The following table shows the annual coal production of Alaska since 1897 and an estimate of the output between 1888 and 1897. A little coal was mined prior 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 prior to 1889, including that mined by the Russians, was probably less than 10,000 tons.

Production of coal in Alaska, 1888–1910.

Year.	Amount (short tons).	Value.	Year.	Amount (short tons).	Value.
1888–1896	6,000	$84,000	1905	3,774	$13,250
1897	2,000	28,000	1906	5,541	17,974
1898	1,000	14,000	1907	10,139	53,600
1899	1,200	16,800	1908	3,107	14,810
1900	1,200	16,800	1909	2,800	12,300
1901	1,300	15,600	1910	1,000	15,000
1902	2,212	19,048			
1903	1,447	9,782	Total	44,414	338,189
1904	1,694	7,225			

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.

ARIZONA.[1]

Although the Territory of Arizona has not produced any coal on a commercial scale, there are fields of much promise which may be profitably exploited when transportation is afforded and when the population and manufactures have reached a point which will provide a market for the output. The more important of these fields is the Black Mesa coal fields in the Hopi and Navajo Indian Reservations, which are included within Coconino, Navajo, and Apache counties. This area was visited by M. R. Campbell, of the Geological Survey, in May, 1909. The examination was merely of a reconnaissance character, and the results of Mr. Campbell's observations are contained in Survey Bulletin 431, page 229. It is Mr. Campbell's opinion that the coal-bearing rocks of the Black Mesa field are similar to those of the San Juan and Gallup regions, New Mexico, and it seems probable that they are the same.

The structure of the Black Mesa region is simple. It is a flat, open, synclinal basin, sharply upturned along the northwest side, but very flat along the other sides. There appear to be two main groups of coal beds. From the sections so far obtained the coal appears to be in rather thin benches, alternating with layers of shale and bone, which will make mining somewhat expensive. When the coal is separated from the layers of bone and shale, it is found to be higher in fixed carbon than that of the Gallup district of the San Juan River

[1] See map (Pl. VIII) accompanying description of coal fields of New Mexico.

to the east, but lower in calorific value. Mr. Campbell estimates that in the total area of coal in the Black Mesa fields there are 5,920 square miles, and that the entire contents of the fields are 14,082,000,000 short tons, of which 8,000,000,000 tons are recoverable.

The Deer Creek coal has been described by Mr. Campbell in Survey Bulletin 225, pages 240–258, from which the following notes are extracted:

The Deer Creek field occupies an irregular, synclinal basin between the Mascal Range on the north and an unnamed range on the south. It lies in an isolated basin in the extreme eastern end of Pinal County. It is not a large area, extending from 10 to 12 miles in an east-west direction and being between 3 and 4 miles wide. This coal field is near the middle of the copper-producing region of Arizona, but is without railroad transportation, and is consequently inaccessible at the present time. The major portion of the field is drained by Deer Creek. The coal-bearing rocks extend to the southwest to Saddle Mountain, beyond the Gila River, but in that region are so broken and disturbed that the coal is presumably of no value.

The structure of the Deer Creek fields is comparatively simple, consisting of a long, symmetrical, synclinal trough, whose axis corresponds approximately to the course of Deer Creek, near the south side of the basin. Existence of coal in the basin has been known for nearly 30 years, but no commercial development has been attempted. Mr. Campbell thinks it safe to assume that there are two beds of workable thickness throughout the larger part of the basin. Its area is about 30 square miles. The beds are thin, but from the sections obtained the coal ranges from 24 to 30 inches in thickness. The tonnage of the field, based upon an estimate of 24 inches of coal through the 30 square miles, is about 60,000,000 short tons, of which about one-half might be considered available.

There are two grades of coal, one being a hard, block coal, well adapted for transportation and for commercial uses, and also possessing some coking quality; the other is a soft, badly crushed coal, which carries a high percentage of ash and could probably not be marketed except very locally. It is believed, however, that as this lower grade of coal is high in volatile matter it could be used for the manufacture of gas, to be piped to the places of consumption, or used in the development of electrical power.

ARKANSAS.

Total production in 1910, 1,905,958 short tons; spot value, $2,979,213.

The coal-mining industry of Arkansas, like that of the other States of the western interior region (except Iowa), was practically out of business for six months of 1910. The strike which began on April 1 and lasted until September 15 affected nearly 90 per cent of all the coal-mine employees in Arkansas, and the total time lost was within 1 per cent of the total time made during the year. The total time worked amounted to 713,794 days and the time lost was 713,210 days. In all the States affected by the strike effort to make provision against it was made during January, February, and March, the operators being inspired by a desire to accumulate stocks of coal and the miners by the necessity for increasing their earnings in order to tide over the period of idleness. It was recognized that the struggle would be bitter and prolonged and both sides made preparation in advance. After operations were resumed, about October 1, every ton of coal which it was possible to mine with the available labor was mined. The activity before and after the strike made up for a part of the loss in tonnage during the summer, so that instead of a decrease in production of 50 per cent, proportionate to the loss in time, the output decreased only 471,199 short tons, or 19.8 per cent, from 2,377,157 short tons in 1909 to 1,905,958 tons in 1910. The value decreased from $3,523,139 to $2,979,213, a loss of $543,926, or 15.44 per cent.

The most serious effects of this strike and of the regularly recurrent difficulties every two years are the loss of markets through the invasion of coals from other States and the encouragement given to large consumers to substitute oil or natural gas for fuel to the displacement of coal. Many such changes have already been made. Another evil effect is the migration of miners to other fields, and in Arkansas and the adjoining State of Oklahoma this is particularly serious, for mining conditions in these States are not as attractive as in some others, and miners once leaving seldom return. The mining force has therefore to be recruited from inexperienced labor, which is always unsatisfactory and, in the long run, expensive. As the conditions in Arkansas and Oklahoma are much the same, the reader is referred to the discussion of the production in Oklahoma for further comment on the mining situation in the two States.

There were 5,568 men employed in the coal mines of Arkansas in 1910, and they averaged 128 working days each; there were 4,873 men on strike, and the average time lost by each of these was 146 days. The total working time made by the 5,568 men was 713,794 days, and the total time lost by the 4,873 men was 713,210 days. In 1908, when the statistics of labor and production were somewhat comparable with 1910, 5,337 men worked an average of 145 days in the production of 2,078,357 tons of coal. The average production for each man employed was 342 tons in 1910 and 389 tons in 1908. The average daily production per man was 2.67 tons in 1910 and 2.68 tons in 1908. Since 1902, when the coal-mine workers of Arkansas were organized, the mines have been operated on an 8-hour day.

Only a small quantity of coal is mined by machines in Arkansas—13,383 short tons in 1910. As in Oklahoma, notwithstanding all that has been said and written in condemnation of the practice, most of the coal in Arkansas is "shot from the solid." This not only adds to the hazard of mining, but injures the quality of the product in the unnecessary quantity of slack produced, and depreciates the value of the lump coal, which, according to complaints of consumers, disintegrates because of the strain put upon it in the blasting. But it is easier to shoot down the coal with a large charge of explosive than it is to undercut it, even with a machine.

One company in Arkansas has installed a washing plant, and 59,702 short tons of coal were washed in 1910, yielding 44,169 tons of cleaned coal and 15,533 tons of refuse.

The statistics of production, by counties, for 1909 and 1910, with the distribution of the product for consumption, are shown in the following table:

Coal production of Arkansas in 1909 and 1910, by counties, in short tons.

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	64,169	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

1910.

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	281,025	2,300	13,400	296,725	$430,338	$1.45	132	772
Johnson	126,241	854	6,270	133,365	296,176	2.22	96	730
Logan	11,866	2,916	710	15,492	38,638	2.49	93	129
Sebastian	1,374,491	5,299	45,557	1,425,347	2,131,888	1.50	140	3,613
Other counties [a] and small mines	28,399	1,743	4,887	35,029	82,173	2.35	79	324
Total	1,822,022	13,112	70,824	1,905,958	2,979,213	1.56	128	5,568

[a] Pope, Scott, and Washington.

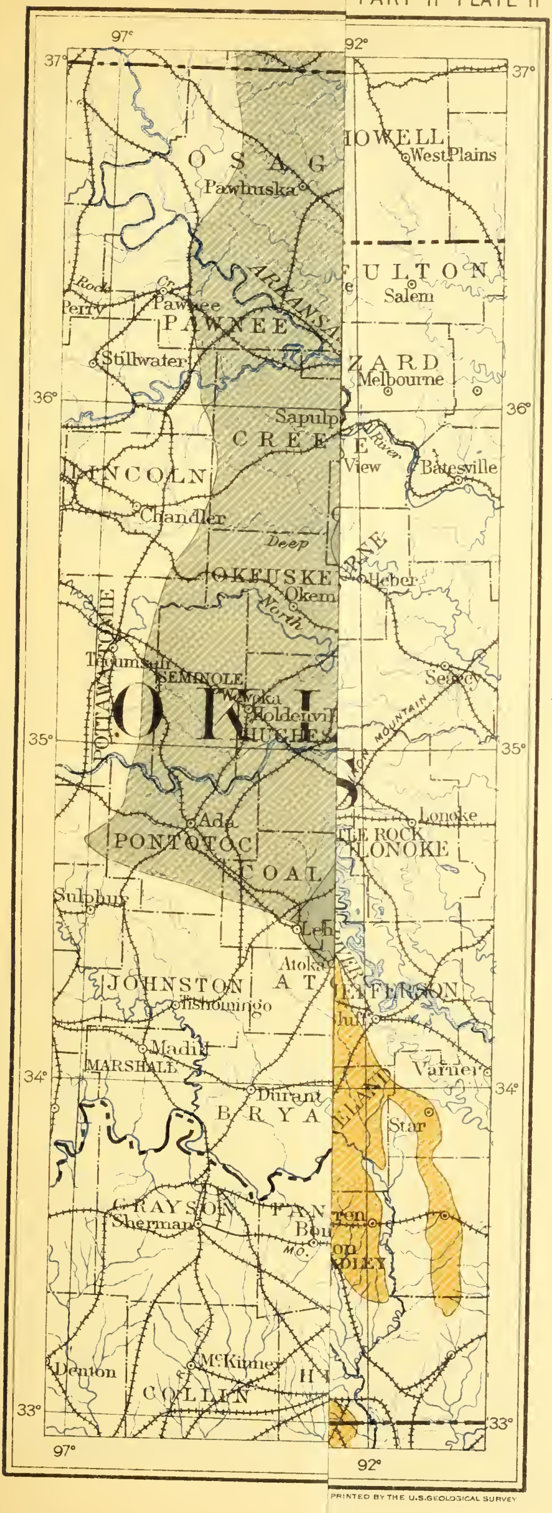
A statement of the production of coal in Arkansas, by counties, for the last five years, with increase and decrease in 1910 as compared with 1909, is shown in the following table:

Coal production of Arkansas, 1906–1910, by counties, in short tons.

County.	1906	1907	1908	1909	1910	Increase (+) or decrease (—), 1910.
Franklin	[a] 489,434	[a] 666,735	[a] 400,995	281,399	296,725	+ 15,326
Johnson	....	....	....	171,102	133,365	— 37,737
Logan	26,647	29,970	30,723	25,169	15,492	— 9,677
Pope	34,776	47,753	35,481	56,344	13,240	— 43,104
Sebastian	1,278,497	1,875,386	1,580,778	1,818,781	1,425,347	— 393,434
Other counties and small mines	34,914	50,594	30,380	24,362	21,789	— 2,573
Total	1,864,268	2,670,438	2,078,357	2,377,157	1,905,958	— 471,199
Total value	$3,000,339	$4,473,693	$3,499,470	$3,523,139	$2,979,213	—$543,926

[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 20 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



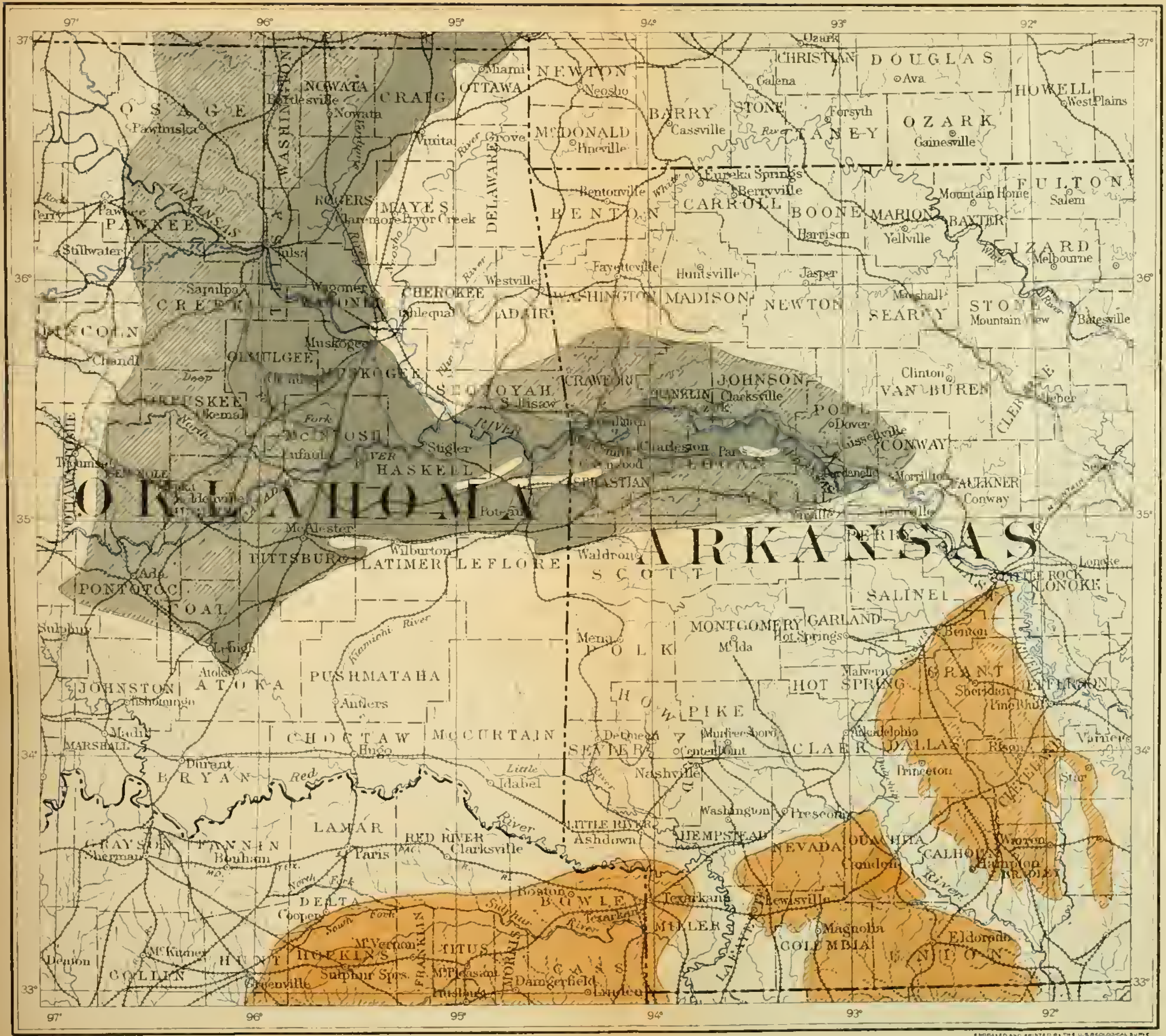
LEGEND

Areas known to contain workable semianthracite and bituminous coal

Areas that may contain workable coals

Areas known to contain workable lignite

Areas possibly containing workable lignite



LEGEND

Areas known to contain workable semianthracite and bituminous coal

Areas that may contain workable coals

Areas known to contain workable lignite

Areas possibly containing workable lignite

COAL FIELDS OF ARKANSAS AND OKLAHOMA

Scale $\frac{1}{2500000}$

25 0 25 50 75 100 Miles

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 20 years, with the exception of 1904, 1905, and 1906, the production has increased quite rapidly, reaching a maximum of 2,670,438 short tons in 1907.

The total original supply of coal in Arkansas was 1,887,000,000 short tons,[1] of which 1,797,000,000 tons were bituminous and semianthracite, and 90,000,000 tons were lignite. The lignite areas have not been developed and no production has been reported from them. From the bituminous and semianthracite areas there have been mined, to the close of 1910, 30,117,873 short tons, representing an exhaustion, including waste, of approximately 45,000,000 tons, or 2 per cent of the estimated original contents of the Arkansas fields. Of the total amount of coal produced in Arkansas from the time when mining began, 6 per cent was mined in 1910, in which year the output also represented about 0.11 per cent of the estimated original supply.[2]

The annual production of coal in Arkansas from 1840 to the close of 1910 will be found in the following table:

Production of coal in Arkansas from 1840 to 1910, in short tons.

Years.	Quantity.	Years.	Quantity.	Years.	Quantity.	Years.	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	1910	1,905,958
1884	75,000	1893	574,763	1902	1,943,932		
1885	100,000	1894	512,626	1903	2 229,172	Total	30,117,873
1886	125,000	1895	598,322	1904	2,009,451		

THE COAL FIELDS OF ARKANSAS.

Arkansas contains two coal fields (Pl. II), one of high-grade fuel in the western part of the State, and the other of lignite, in the lowlands southeast of Hot Springs and Little Rock. The latter has never been adequately developed, because lignite has had little or no commercial value and it is probable that this field will not be an important factor in the fuel production of the State for some time to come.

The field of high-grade fuel lies along Arkansas River, extending from the Oklahoma State line on the west to Russellville on the east, a distance of about 75 miles. In the north-south direction its dimension, though differing much in different localities, probably averages about 20 miles. It includes in whole or in part the counties of Sebastian, Franklin, Johnson, Pope, Logan, Scott, and Crawford, but nearly all of the coal at present mined comes from the four counties standing at the head of the list.

The field consists of a series of synclinal basins or troughs in the Carboniferous rocks, and on account of this structure the coal beds are exposed almost entirely around the margin of the field and at

[1] Campbell, M. R., Coal fields of the United States, U. S. Geol. Survey, 1908.
[2] For detailed description of the Arkansas coal field see Bull. U. S. Geol. Survey No. 316, 1906, p. 137.

many places in the interior where erosion has cut low enough to expose its horizon on the anticlinal folds between the basins.

Only a few coal beds occur in this field. The most important bed, and the one from which probably 99 per cent of the coal mined in the State is derived, corresponds with the Hartshorne coal of Oklahoma, and in fact is the direct eastward extension of that bed. This coal is mined extensively at Huntington, Hartford, Midland, Bonanza, Jenny Lind, Greenwood, and other places in Sebastian County; at Denning and Altus, in Franklin County; at Clarksville, in Johnson County; and in the vicinity of Russellville, in Pope County.

The Charleston coal bed, about 700 feet higher than the Hartshorne bed, is mined in a small way about Charleston, Franklin County; and the Paris bed, about 300 feet higher than the Charleston, is mined locally in the vicinity of Paris, Logan County. Another small coal bed lies about 500 feet below the Hartshorne, but it is irregular and of little value, and at the present time is not mined on a commercial scale at any place in the State.

In quality the coal increases from west to east. The fuel ratio (fixed carbon divided by volatile matter) ranges from about 3.5 in the vicinity of the State line on the west to 5 at Denning and Coal Hill, 6.5 at Spadra, and about 8 at Russellville. In other words, the coal in the western part of the field belongs to the class called semibituminous, and that of the east to the class called semianthracite. The semibituminous coal of the western half of the field is exceedingly tender and friable and, as delivered at the mine mouth, consists of from 20 to 30 per cent fine coal. This fine coal is of excellent quality, but does not find a ready market, and frequently can not be disposed of at any price. This condition makes mining expensive and unsatisfactory.

CALIFORNIA.

Total production in 1910, 11,164 short tons; spot value, $18,336.

In 1909 California showed the largest percentage of increase among the coal-producing States. In 1910 it showed the largest percentage of decrease. Both were due to the operations of the Stone Cañon Consolidated Coal Co., in Monterey County. For two years preceding 1909 this company had expended large amounts of money in developing its property and in building a railroad 25 miles in length to connect its mine with the Southern Pacific Railroad. Unfortunately difficulties unforeseen were encountered, and one misfortune followed another until the resources of the company were exhausted and, as it was unable to secure additional capital, a receiver was appointed and work was suspended in October, 1909. In the nine months from January to September the Stone Canyon mines had produced 75 per cent of the State's output for the entire year. No coal was produced at these mines in 1910 and the production for the State decreased from 45,836 tons in 1909 to 11,164 tons in 1910.

All of the production in 1910 was from Amador and Riverside counties, principally from the Ione mine in Amador County. All of this is lignite. The Stone Canyon coal is a noncoking bituminous coal of good quality and should make an excellent domestic fuel. It stands exposure well and with favorable freight rates would compete successfully with foreign coals in the markets of San Francisco and other cities of the State.

The lack of coal production in California is made up by the enormous increase in the production of petroleum, most of which is used for fuel. The production of petroleum in California in 1910 aggregated between 65,000,000 and 70,000,000 barrels, which, on the basis of 3½ barrels of oil for each ton of high-grade coal, would be equal to a production of nearly 20,000,000 tons of coal in that State in 1910.

The use of petroleum by the transportation and manufacturing industries of California has practically eliminated coal as a steam-raising fuel in the State. Oil is also used in the manufacture of gas, which is used for cooking, and for heating residences as well as for lighting. Oil is now also coming into use as a direct fuel for household purposes.

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

Distribution of the coal product of California, 1905–1910, 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
1910	6,679	3,985	500	11,164	18,336	1.64	192	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.

Production of coal in California from 1861 to 1910, 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	1910	11,164
1872	190,859	1885	71,615	1898	145,888		
1873	183,611	1886	100,000	1899	160,915	Total.	5,106,700

THE COAL FIELDS OF CALIFORNIA.

There are in California a number of small, widely separated coal fields, chief among which are the Mount Diablo field of Contra Costa County, the Corral Hollow field of Alameda County, the Priest Valley and Trafton fields of San Benito County, and the Stone Canyon field of Monterey County.

The coal of these fields has all been classed as lignite or lignitic, largely on account of its recent geologic age. As a matter of fact, there is a decided increase in quality from north to south, the northernmost two fields being subbituminous ("black lignite"), the middle field closely approaching bituminous, and the southernmost or Stone Canyon field being distinctly bituminous. The distinction between these two classes is based upon the manner in which they weather. Subbituminous coal "slacks" quickly on exposure to the atmosphere, but bituminous coal shows little or no effect except when exposed for a long period of time.

At various times during the last 10 years efforts have been made to exploit these fields, but they have not been successful, and at present all are idle, with little prospect of a resumption of operations. The field to be exploited last is that of Stone Canyon, where a large sum of money was invested in building a railroad, opening the mine, and constructing tipple, miners' houses, etc. Unfortunately, before this was completed a flood washed away the branch railroad line, and the company was obliged to suspend operations. This coal is the best so far discovered in the State, and it is unfortunate that the effort to place it on the San Francisco market has been unsuccessful.

COLORADO.

Total production in 1910, 11,973,736 short tons; spot value, $17,026,934.

In the production of coal Colorado ranks first among the States west of Mississippi River and seventh among all the coal-producing States. Its position among the Western States was strengthened by the record made in 1910, for, whereas in some of the Rocky Mountain States there were larger percentages of increase in 1910 over 1909, Colorado's increase was the largest in point of tonnage and was more than one-third of the total increase made in the seven States comprising the Rocky Mountain and Great Plains provinces. In the Mississippi Valley States the production in 1910 was materially cut down by the miners' strike, which began on April 1 and was continued with few exceptions for nearly six months. The cessation of operations among the miners in the Southwestern States created an unusual demand upon the mines of Colorado, New Mexico, and Wyoming, the demand coming principally from the railroads running between the Rocky Mountains and Mississippi River. There was also a better demand for domestic fuel, and considerable quantities of coal for winter use were stored in the cellars of housekeepers.

The influence of the strike upon Colorado's coal production was exhibited in an increase of 1,256,800 short tons, or 11.73 per cent, from 10,716,936 short tons in 1909 to 11,973,736 tons in 1910. The value increased from $14,296,012 to $17,026,934, a gain of $2,730,922, or 19.1 per cent. The average price per ton advanced from $1.33 in 1909 to $1.42 in 1910.

The Trinidad-Raton coal field, the Colorado portion of which is located in Las Animas County, is the most important producer in the State, and was credited with more than three-fourths of the total increase for the State in 1910. Las Animas County produces nearly 50 per cent of Colorado's total, contributing in 1910, 5,548,085 short tons out of a total of 11,973,736 tons. The county's increase in 1910 over 1909 was 955,121 short tons, or 20.79 per cent. Huerfano County, the second in production, with 20 per cent of the State's total, increased its ouput 471,180 tons, or 24.59 per cent. Routt County held to the promise made in 1909, with an increase of nearly 180 per cent, from 92,439 tons in 1909 to 258,452 tons in 1910. This county in 1908 was credited with an output of 13,000 tons, the production in 1910 being twenty times that quantity. The completion in 1909 of the Denver, Northwestern & Pacific Railway has afforded opportunity for the development of the coal resources in the northwestern part of Colorado, and Routt County is destined to be one of the more important coal-producing counties in the State. The only other county whose production increased more than 100,000 tons in 1910 was Fremont, which gained 110,162 tons. The increase in these counties was partly offset by a marked decrease in Boulder County, the production of which, in 1909, had been unhealthily forced in a keen competition for the Denver trade. The output was increased from 1,067,948 tons in 1908 to 1,332,322 tons in 1909, but with a decided sacrifice in prices. In 1910 the production fell off to 802,769 tons, a decrease of 529,553 tons, or 39.7 per cent, and prices were restored.

The number of men employed in the coal mines of Colorado in 1910 was 15,864, who worked an average of 236 days. The average production for each man employed was 755 tons for the year and 3.20 tons for each day worked. Of the 15,864 men employed, 2,044 were on strike for an average of 96 days each, the total loss in working time being 195,558 days, equivalent to a loss in production, at the average rate in 1910, of about 600,000 short tons.

Notwithstanding the increase in the total production of coal in Colorado in 1910, the quantity of coal mined by machines was a little less. The number of machines reported in use increased from 253 in 1909 to 256 in 1910, but the quantity of machine-mined coal decreased from 1,929,545 short tons to 1,905,781 tons. No reason for the decreased use of machines was reported.

The statistics of production in Colorado in 1909 and 1910, with the distribution of the product for consumption, are shown in the following table:

Coal production of Colorado in 1909 and 1910, by counties, in short tons.

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[a]	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, Jefferson, Montezuma, Pitkin, and Rio Blanco.

Coal production of Colorado in 1909 and 1910, by counties, in short tons—Continued.

1910.

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	748,528	13,155	41,086	....	802,769	$1,235,463	$1.54	159	1,502
Delta	55,203	8,037	350	....	63,590	107,290	1.69	249	71
El Paso	196,225	129,769	10,786	....	336,780	453,877	1.35	278	379
Fremont	678,948	14,475	28,719	....	722,142	1,627,567	2.25	215	1,403
Garfield	177,324	5,474	6,957	....	189,755	286,017	1.51	157	271
Gunnison	571,469	3,919	20,794	44,800	640,982	994,511	1.55	211	862
Huerfano	2,310,565	7,320	69,205	....	2,387,090	3,956,794	1.66	227	3,188
La Plata	135,649	10,681	1,425	....	147,755	252,052	1.71	231	192
Las Animas	3,756,141	39,631	109,645	1,642,668	5,548,085	6,469,805	1.17	266	6,547
Mesa	103,285	23,729	2,516	....	129,530	188,618	1.46	211	151
Routt	248,760	2,664	7,028	....	258,452	437,979	1.69	256	355
Weld	286,556	21,968	14,372	....	322,896	460,758	1.43	185	486
Other counties[a]	294,410	9,644	17,634	97,524	419,212	547,655	1.31	278	457
Small mines	....	4,698	....	....	4,698	8,548	1.82	....	....
Total	9,563,063	295,164	330,517	1,784,992	11,973,736	17,026,934	1.42	236	15,864

[a] Archuleta, Jackson, Jefferson, Larimer, Pitkin, and Rio Blanco.

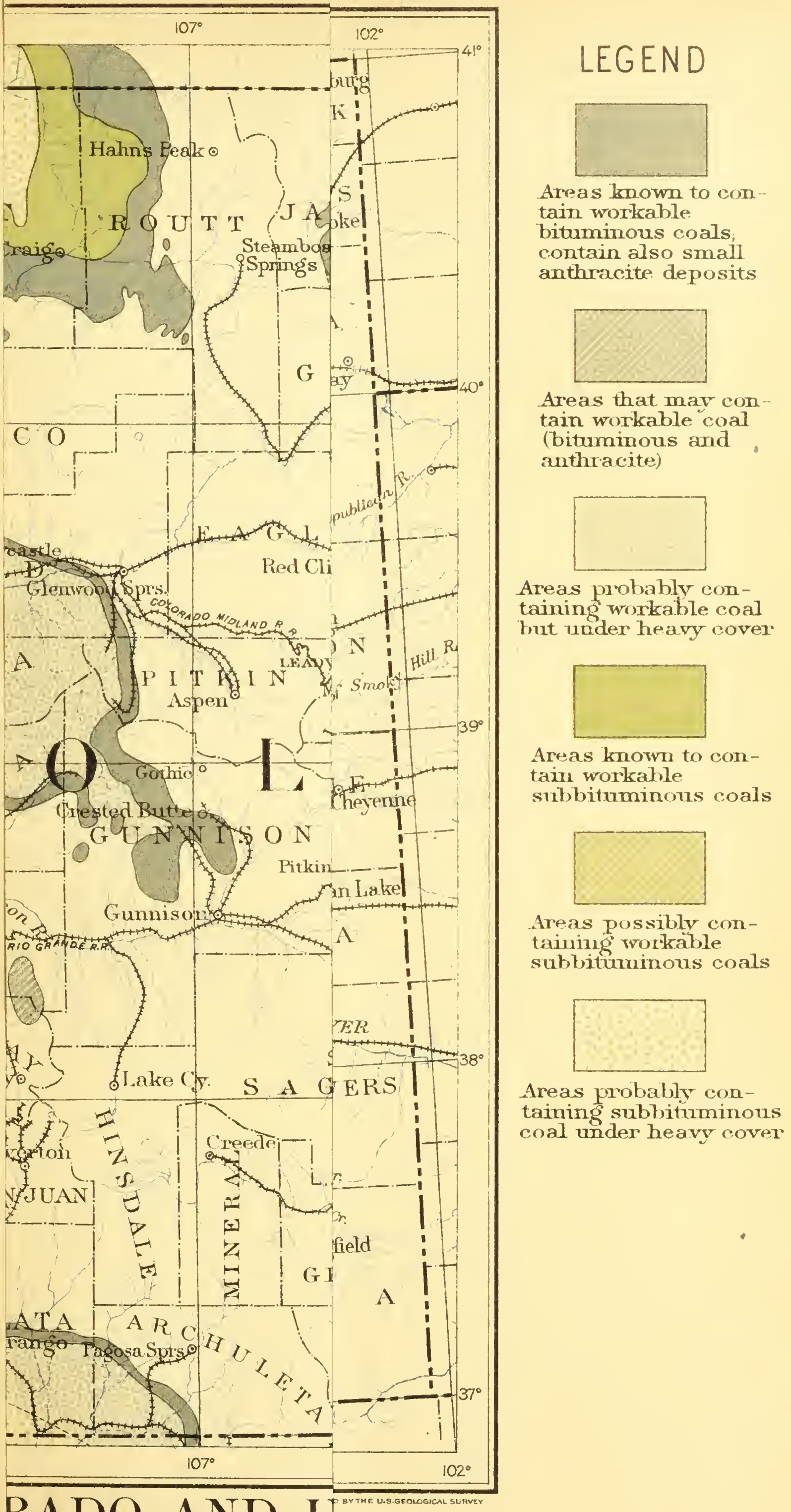
The statistics of production, by counties, during the last five years, with increase and decrease in 1910 as compared with 1909, are given in the following table:

Coal production in Colorado, 1906–1910, by counties, in short tons.

County.	1906	1907	1908	1909	1910	Increase(+) or decrease (−), 1910.
Boulder	1,022,096	1,296,729	1,067,948	1,332,322	802,769	− 529,553
Delta	6,812	22,087	37,689	55,031	63,590	+ 8,559
El Paso	210,793	269,795	317,763	312,233	336,780	+ 24,547
Fremont	666,034	784,949	669,274	611,980	722,142	+ 110,162
Garfield	193,063	220,040	220,099	257,796	189,755	− 68,041
Gunnison	583,175	576,859	503,140	598,463	640,982	+ 42,519
Huerfano	1,803,791	1,797,790	1,644,068	1,915,910	2,387,090	+ 471,180
Jefferson	212,037	193,814	163,624	195,809	227,744	+ 31,935
La Plata	173,720	184,018	166,090	139,858	147,755	+ 7,897
Las Animas	4,768,882	4,885,105	4,190,801	4,592,964	5,548,085	+ 955,121
Pitkin	319,529	313,866	228,828	159,753	183,068	+ 23,315
Routt	5,297	5,690	13,005	92,439	258,452	+ 166,013
Weld	95,420	136,074	343,414	327,545	322,896	− 4,649
Other counties	50,569	103,420	69,230	124,833	142,628	+ 17,795
Total	10,111,218	10,790,236	9,634,973	10,716,936	11,973,736	+ 1,256,800
Total value	$12,735,616	$15,079,449	$13,586,988	$14,296,012	$17,026,934	+$2,730,922

Coal mining as an industry in Colorado began in 1864, a production of 500 short tons being recorded in that year. In 1876 the production reached for the first time a total exceeding 100,000 tons, and six years later, in 1882, it 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 38 years. The largest decrease was in the "hard-times" year, 1894. The coal production of the State exceeded 3,000,000 tons in 1890; 10 years later it had grown to over 5,000,000 tons; and in 1910 it exceeded 11,000,000 tons.

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



RADO AND U

75 100 Miles

COAL FIELDS OF COLORADO AND UTAH

Scale $\frac{1}{2600000}$

Production of coal in Colorado from 1864 to 1910, in short tons.

Years.	Quantity.	Years.	Quantity.	Years.	Quantity.	Years.	Quantity.
1864	500	1877	160,000	1890	3,077,003	1903	7,423,602
1865	1,200	1878	200,630	1891	3,512,632	1904	6,658,355
1866	6,400	1879	322,732	1892	3,510,830	1905	8,826,429
1867	17,000	1880	462,747	1893	4,102,389	1906	10,111,218
1868	10,500	1881	706,744	1894	2,831,409	1907	10,790,236
1869	8,000	1882	1,061,479	1895	3,082,982	1908	9,634,973
1870	4,500	1883	1,229,593	1896	3,112,400	1909	10,716,936
1871	15,600	1884	1,130,024	1897	3,361,703	1910	11,973,736
1872	68,540	1885	1,356,062	1898	4,076,347		
1873	69,997	1886	1,368,338	1899	4,776,224	Total	144,993,981
1874	77,372	1887	1,791,735	1900	5,244,364		
1875	98,838	1888	2,185,477	1901	5,700,015		
1876	117,666	1889	2,597,181	1902	7,401,343		

THE COAL FIELDS OF COLORADO.

The coal fields of Colorado (Pl. III) lie in deep synclinal basins along the lower flanks and among the foothills of the mountains. They are thus naturally divided by the major ranges and have been described as containing three groups, namely, the eastern, the park, and the western groups. The eastern group comprises the following distinct coal fields: Trinidad, Canon City, and South Platte. The park group includes the fields in South, Middle, and North parks; and the western group, which is the largest and contains the greatest amount of coal, includes the Yampa field in the extreme north; Danforth Hills, White River, and Grand Hogback fields north of Grand River, Glenwood Springs coal basin, Crested Butte, and Grand Mesa fields directly south of Grand River; the Book Cliffs field west of Grand Junction; and the Durango field in the southwestern part of the State.

Until recently all of the coals of Colorado were regarded as occurring in the Laramie formation except a small quantity in the Dakota sandstone. Recent work has shown, however, that most of the coal is contained in the Mesaverde formation which belongs in the Montana group of the Upper Cretaceous, and that only a small part belongs to the Laramie, Dakota, and the lower part of the Tertiary system.

In regard to quality, the coals of the State have a wide range, extending from subbituminous ("black lignite") in the South Platte field, through the various grades of bituminous, including the high-grade coking coal of Trinidad and Glenwood Springs, to anthracite in the Crested Butte field. On account of their nearness to Denver and other important markets the low-grade coal of the South Platte field has been extensively mined, as has also the high-grade fuel of the Trinidad and the Canon City fields. The Park fields are not well known; in fact, little or no development has been attempted in them except in South Park, and these mines were abandoned many years ago. In the western fields active work is carried on in a large way in the Glenwood Springs and Crested Butte fields, and to a limited extent about Durango, Grand Junction, and Steamboat Springs. Activity in the last-named locality dates only from the completion of the Denver, Northwestern & Pacific Railroad into this part of Routt County, in 1906.

The undeveloped fields now attracting most attention are the North Park field, the Yampa field of Routt County, and the fields along or tributary to White River. The reason that these fields are particularly prominent is that railroads are either being surveyed or under actual construction toward them, and in the near future they may become important elements in the fuel production of the State.

The coal beds of North Fork are reported to be very thick, but there is some doubt about the quality of the coal. The coal of the Yampa field is an excellent steam and domestic fuel, and a small amount of anthracite occurs in the vicinity of Pilot Knob and also is reported in the Flattops west of the town of Yampa. There are local occurrences due to the metamorphic action of igneous rocks. A large extent of territory in the northern part of this field is underlain by the "Laramie" formation which contains thick beds of coal that are practically untouched. This coal is of low grade, but owing to the great number and thickness of the beds will doubtless become valuable as the higher grades are exhausted.

An equally valuable field in the Danforth Hills lies along the upper valley of White River south of Axial Basin. The coals found here are equal in quality, and in thickness and number, to those of the Yampa field. The coal fields extend westward on Lower White River, and southward along the Grand Hogback to Grand River and beyond, where they are extensively developed in many places. Excellent coals are mined and coked in Pitkin County, and the products are shipped east across the mountains to the smelters. The anthracite of the Crested Butte region is of high quality and has long been on the Denver and other markets of this region. The Book Cliffs and Grand Mesa fields on Grand and Gunnison rivers are continuous with equally important fields of Utah, also yielding high-grade steaming coal.

The known area of Colorado coal fields has been somewhat extended by recent investigations in the lower White River valley. An area of 250 to 300 square miles hitherto described in the geologic reports as occupied wholly by Tertiary strata, which was therefore supposed to contain the valuable coal beds buried beyond available depth, has been found to be almost entirely composed of the outcrop of the Mesaverde or coal-bearing formation. The field contains a number of valuable coal beds, and is situated in the valley of Douglas Creek south of Rangely or Raven Park, and just north of the Book Cliffs divide. The coal beds are in the same formation (Mesaverde) as those mined north of Grand River near the Colorado-Utah State line.

The fields in the southwestern part of the State have been well known for some time. The accessibility of the coal and the growth of the metal-mining and smelting interests in that region have contributed to a more extensive development of the coal resources than has obtained in most of the fields farther north. Coal beds occur in both the Mesaverde and the "Laramie" formations, but the better coal is limited to the formation first mentioned.

Mr. Campbell's estimate[1] of the coal fields of Colorado shows that the area containing or which may contain, workable coal beds amounts to 17,130 square miles, of which 10,130 square miles are estimated to contain workable coal; 4,180 square miles may contain workable coal, but the information about this area is uncertain; and 2,820 square miles contain coal under heavy cover. The original

[1] Campbell, M. R., Coal fields of the United States, U. S. Geol. Survey, 1908.

contents of these areas is estimated to have been 371,770,000,000 short tons.

The production of coal in Colorado up to the close of 1910 aggregated 144,993,981 short tons, and assuming that for each two tons of coal mined one ton was wasted, this production represents an exhaustion of 217,000,000 short tons, or a little less than 0.06 of 1 per cent of the estimated original supply.

GEORGIA.

Total production in 1910, 177,245 short tons; spot value, $259,122.

With the exception of the "boom" year, 1907, the production of coal in Georgia has steadily declined since 1903, when the maximum product of 416,951 short tons was obtained. The production in 1910 was only a little more than 40 per cent of that made in 1903, and was less than half the output of 1907. Compared with 1909, when the production amounted to 211,196 short tons, valued at $298,792, the record for 1910 shows a decrease of 33,951 short tons, or 16 per cent, in quantity, and of $39,670, or 13.3 per cent, in value. It is apparent from the smaller percentage of the decrease in value from 1909 to 1910 and from advances in the average price per ton from $1.38 in 1907 and 1908 to $1.41 in 1909 and to $1.46 in 1910, that the decrease in production was not due to any marked falling off in demand. The coal areas of Georgia are of very limited extent, but the product is a high quality bituminous grade and is in good demand as a steam fuel and for bunker trade at South Atlantic ports. Scarcity of labor is the cause assigned for the decreased output. Prior to 1908 the mines were worked almost exclusively by convicts leased from the State. The contract system for the employment of convict labor has been severely criticized, and, on account of the opposition developed, the State authorities have withdrawn the convicts from the coal mines and the operators have not been able to secure sufficient free labor in this somewhat isolated district to keep the mines working to their normal capacity.

All of the coal produced in Georgia is hand mined, no machines being employed. The total number of men employed in 1910 was 386, who worked an average of 265 days, and as the production amounted to 177,245 short tons the average production for each man employed was 459 tons for the entire year, and 1.73 for each working day.

Labor troubles in 1910 were limited to one strike, in which 270 men were engaged. The strike lasted but 11 days and did not influence production. Of the 3 mines in the State, 2 worked 9 hours a day and 1 worked 9½ hours.

At one establishment the slack coal used in the manufacture of coke is washed before being charged into the ovens. In 1910 84,073 short tons of coal were washed, yielding 78,208 tons of cleaned coal and 5,865 tons of refuse.

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, 1906–1910, 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.
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
1910	94,330	776	2,760	79,379	177,245	259,122	1.46	265	386

Portions of two counties in the extreme northwestern corner of Georgia are underlain by the coal measures of the southern Appalachian coal fields. (See map of the coal fields of Alabama, Georgia, and Tennessee accompanying the description of the Alabama fields.) The Walden Basin of Tennessee crosses Dade County in Georgia, and extending southwesterly becomes the Blount Mountain and Warrior basins in Alabama. The Lookout Basin, a narrow outlying area, extends from Etowah County in Alabama in a northeasterly direction into Walker County, Ga. The total area of the coal fields in Georgia is estimated at 167 square miles, the smallest coal area of any Appalachian State. Not all of this field is workable. Extensive operations are carried on in both counties, however, some of this coal being highly prized as a steam fuel and finding a ready market for bunker coal at Brunswick and other coast cities. On account of its high percentage (80) of fixed carbon and its low sulphur, the Lookout Mountain coal gives a large product of excellent coke, and about 30 per cent of the output each year 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 Mineral Resources of the United States.

According to the estimates of M. R. Campbell, the total original coal supply of Georgia was 933,000,000 tons, from which there had been mined to the close of 1910, 8,776,959 short tons, representing (including loss in mining) an exhaustion of about 13,000,000 tons. This would leave still in the ground a total of 920,000,000 tons, of which from 600,000,000 to 650,000,000 tons would probably be considered as the available supply.

The annual and total production since 1860 are shown in the following table:

Annual production of coal in Georgia, 1860–1910, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1860	1,900	1874	60,000	1888	180,000	1902	414,083
1861	2,500	1875	80,000	1889	225,934	1903	416,951
1862	3,500	1876	110,000	1890	228,337	1904	383,191
1863	6,000	1877	120,000	1891	171,000	1905	351,991
1864	10,000	1878	128,000	1892	215,498	1906	332,107
1865	10,000	1879	140,000	1893	372,740	1907	362,401
1866	8,000	1880	154,644	1894	354,111	1908	264,822
1867	8,000	1881	168,000	1895	260,998	1909	211,196
1868	10,000	1882	160,000	1896	238,546	1910	177,245
1869	12,000	1883	155,000	1897	195,869		
1870	15,000	1884	150,000	1898	244,187	Total	8,776,959
1871	20,000	1885	150,000	1899	233,111		
1872	25,000	1886	223,000	1900	315,557		
1873	40,000	1887	313,715	1901	342,825		

IDAHO.

Total production in 1910, 4,448 short tons; spot value, $17,426.

There are several somewhat restricted areas in Idaho in which lignite beds occur, but little has been done there in the way of mining until the last five or six years. The districts from which this production has been obtained are the Horseshoe Bend and the Jerusalem, occupying the lower portion of a ridge between Boise and Payette rivers; one near Salmon City, in Lincoln County, and one at the eastern edge of the State, in Bingham and Fremont counties, where the Sublette field of Wyoming extends across the State line. The principal production is in the Salmon district, in Lemhi County. (See map (Pl. VII) of coal fields of Idaho, Montana, and Wyoming accompanying the description of the Montana coal fields.)

The production in Idaho during the last six years has been as follows:

Coal production in Idaho, 1905–1910, 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	1910	4,448	17,426

ILLINOIS.

Total production in 1910, 45,900,246 short tons; spot value, $52,405,897.

Illinois was the storm center of the struggle between the operators and the mine workers which began on April 1, 1910, and tied up the industry in most of the mining districts of this State for nearly six months. It was the most protracted and most bitterly contested of all strikes, numerous as they have been, in the history of bituminous coal mining in the United States. It was ended by the practical surrender of the operators to the demands of the workmen, whose cause was aided by the fact that the strike was limited to Illinois and the Southwestern States and the markets for these coals were being supplied from the product of competing States. Moreover, about the middle of May two of the important districts seceded from the operators' association, made terms with their employees, and resumed work. The operators were not supported by their fellow-operators in other States, but, on the contrary, saw their markets being taken by other fuels, and to prevent permanent loss of their trade they finally surrendered. The miners, on the other hand, were not only sustained and helped by their fellow-workers in other States, but some of them migrated to other States or districts not affected by the strike and obtained employment there, thus being enabled to prolong the struggle indefinitely.

With the mines in most of the coal-producing counties shut down for practically six months of the year, a decrease of from 20 to 30 per cent in production might be expected and in some of the Southwestern States the loss approached those figures, but in Illinois the decrease was surprisingly small. In 1909, when the industry was practically free from labor troubles, the production in Illinois amounted to 50,904,990 short tons, whereas in 1910, with six months of idleness at the majority of the mines, the production amounted to 45,900,246 tons, the decrease as compared with the preceding year being 5,004,744 short tons, or 9.8 per cent. The decrease in value was only $1,116,117, or 2.1 per cent, from $53,522,014 to $52,405,897.

The districts which seceded from the operators' association were contained principally in St. Clair, Madison, and Randolph counties, which supply the St. Louis trade, and all of these counties showed marked increases in production. St. Clair County increased its output 2,316,937 tons, or nearly 70 per cent; Madison County gained 728,975 tons; and Randolph County, 225,664 tons. Vermilion County, in the northeastern part of the State, increased its production 595,295 tons, and reached its normal output. Bond County, which adjoins Madison on the east and is comprised within the seceding districts, increased its production over 50 per cent, but it is a relatively unimportant producer. In addition to these there were 14 other counties which showed gains in production, but with two exceptions they were counties whose principal production is from comparatively small operations which supply local trade, and were not included in the strike order. More than 50 per cent of the net loss in production in 1910 was in the two largest producing counties in the southern part of the State, Saline and Williamson. In Saline County the decrease amounted to 824,280 short tons, and in Williamson it was 1,917,282 tons. The decrease in Williamson County was the largest in the State. Sangamon County suffered the second largest decrease, with a loss of 1,166,723 tons. Other important decreases were in Bureau County (639,106 tons), Franklin (537,741 tons), Fulton (667,090 tons), Grundy (513,820 tons), Lasalle (507,506 tons), Macoupin (743,546 tons), and Marion (359,077 tons).

The decreased production in Illinois and a big increase in West Virginia gave the latter State in 1910 a lead over Illinois of more than 15,000,000 short tons, and has apparently established West Virginia as second in rank among the coal-producing States. Twice before, in 1906 and in 1909, West Virginia's production had exceeded that of Illinois, but in each case the difference was comparatively small.

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 8-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 58 days each. This was equivalent to an average of 48 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 37 days, equivalent to an average idleness of 26 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. In 1910, out of a total of 72,645 men, 67,218 were idle for an average of 136 days and the total time lost was equivalent to 9,133,953 working days. The total time made by the 72,645 men employed was 11,612,966 days, or an average of 160 days each. The idle time in 1910 was nearly 80 per cent of the working time made.

As the average time made was 160 days, and the average time lost was 136 days, it may be considered that a total of 296 days was possible, though such an evidence of continued performance has rarely been shown even by individual mines, and such an average has never been attained. If the number of men idle and employed are taken into consideration, the time lost in Illinois in 1910 was equal to 46 per cent of the maximum time possible. These figures do not mean that in 1906, 1908, and 1910 there were losses of 25, 14, and 80 per cent, respectively, in wages, for in each year before and after the strike there was a greater intensity of labor, and the miners, particularly those who work by contract and are paid by the ton, were able to make up a good deal of the lost time. In 1906, for instance, when the loss of time was 25 per cent, the production increased 8 per cent over 1905. In 1908 the time lost was 14 per cent of the time worked, and the production decreased 7.13 per cent. This decrease was in sympathy with the business depression of that year. In 1910 when the time lost was 80 per cent of the time made and 46 per cent of the possible working time, the decrease in production was 9.8 per cent. 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 are unwise, and it may well be asked if some better method of dealing with the wage controversy may not be evolved.

Although the natural conditions in the Illinois field are favorable to the use of machines for undercutting the coal, Illinois has not made as much progress in this regard as have some of the neighboring and competing States. In 1910, 17,730,298 short tons, or 38.63 per cent of the total production of Illinois was machine-mined, as compared with 17,488,427 tons, or 34 per cent, in 1909. In Indiana about 50 per cent of the total output is mined by machines; Ohio mines about 80 per cent of its total by machines; Kentucky about 60 per cent; West Virginia, 45 per cent; and over 45 per cent of Pennsylvania's bituminous coal is mined by machines.

The State bureau of labor statistics, Mr. David Ross, secretary, reports that in the fiscal year ended June 30, 1910, there were 390 fatal and 737 nonfatal accidents in the coal mines of Illinois. The number of men employed in the fiscal year was 74,634, and the quantity of coal produced, according to Mr. Ross, was 48,717,853 short tons. The death rate per thousand employees was 5.2 and the number of tons mined for each life lost was 124,917.

Mr. Ross has reported to the United States Bureau of Mines that there were 143 men killed and 628 injured in the calendar year 1910. The death rate per thousand employees was 2, and the number of tons mined for each life lost was 320,981.

In 1909 there were 213 fatal and 894 nonfatal accidents; the death rate per thousand was 2.94; and the quantity of coal mined for each life lost was 230,816 short tons. The casualties in 1910 include the Cherry mine fire which occurred in the calendar year 1909 (November) and cost the lives of 259 men.

As previously stated, practically all the coal mines in Illinois are operated 8 hours daily. There were only 7 mines in 1910 that worked 9 hours, and 1 mine worked 10 hours. These 8 mines employed a total of 141 men.

About 5 per cent of the total coal production of Illinois is washed at the mines. Most of the coal washed is nut and is sold to domestic trade. In 1910, 2,453,208 short tons were washed, yielding 2,019,396 tons of cleaned coal and 433,812 tons of refuse.

The statistics of production, by counties, in 1909 and 1910, with the distribution of the product for consumption, are shown in the following table:

Coal production of Illinois in 1909 and 1910, by counties, in short tons.

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	....	....
La Salle	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	....	....
Macoupin	4,435,247	55,796	106,732	....	4,597,775	4,262,484	.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.

Coal production of Illinois in 1909 and 1910, by counties, in short tons—Continued.

1910.

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	867,063	63,626	42,657	....	973,346	$1,488,070	$1.53	157	3,294
Christian	1,058,371	102,620	62,304	....	1,223,295	1,322,162	1.08	134	1,912
Clinton	891,542	16,686	42,015	....	950,243	1,092,752	1.15	186	1,290
Franklin	1,694,295	23,257	61,216	....	1,778,768	2,312,342	1.30	133	2,882
Fulton	1,611,261	66,469	43,797	....	1,721,527	2,253,307	1.31	145	3,448
Gallatin	55,927	10,875	1,720	1,569	70,091	85,000	1.21	154	127
Grundy	547,231	33,960	19,090	....	600,281	968,563	1.61	131	2,257
Henry	78,431	42,746	3,066	....	124,243	225,018	1.81	228	235
Jackson	494,726	41,863	47,651	....	584,240	776,363	1.33	123	1,128
Knox	....	27,549	746	....	28,295	54,174	1.91	200	81
La Salle	839,173	290,656	49,056	....	1,178,885	2,032,002	1.72	171	3,171
Livingston	105,208	49,625	8,065	....	162,898	262,056	1.61	135	413
Logan	337,604	50,230	21,410	....	409,244	469,657	1.15	152	788
McDonough	9,252	16,843	243	....	26,338	61,194	2.32	181	88
Macon	116,471	110,306	8,584	....	235,361	387,713	1.65	177	492
Macoupin	3,665,759	63,399	125,071	....	3,854,229	3,479,049	.90	176	4,570
Madison	3,878,517	134,741	89,515	....	4,102,773	4,222,078	1.03	202	3,924
Marion	760,588	24,595	27,690	....	812,873	801,117	.99	152	1,256
Marshall	213,590	44,545	9,312	....	267,447	466,724	1.75	159	1,032
Menard	278,225	43,698	10,634	....	332,557	464,375	1.40	199	512
Mercer	201,081	19,025	8,918	....	229,024	343,115	1.50	138	560
Montgomery	1,709,995	50,284	39,441	....	1,799,720	1,907,006	1.06	159	2,374
Peoria	683,440	113,232	13,923	....	810,595	1,042,478	1.29	157	1,463
Perry	1,303,716	22,940	41,115	....	1,367,771	1,411,553	1.03	157	2,310
Randolph	973,761	26,544	25,252	....	1,025,557	1,065,969	1.04	200	1,165
Rock Island	13,449	50,766	1,992	....	66,207	109,433	1.65	179	79
St Clair	5,417,001	241,940	129,626	....	5,788,567	5,763,249	1.00	195	5,598
Saline	2,389,033	30,811	39,806	....	2,459,650	2,713,514	1.10	134	4,248
Sangamon	4,076,071	246,223	127,340	....	4,449,634	5,014,237	1.13	151	7,099
Shelby	105,504	24,893	5,275	....	135,672	179,291	1.32	137	354
Stark	14,630	17,302	650	....	32,582	53,056	1.63	216	56
Tazewell	90,800	62,166	2,693	....	155,659	210,824	1.35	174	327
Vermilion	2,251,534	215,893	47,823	....	2,515,250	2,691,574	1.07	205	3,540
Williamson	4,354,824	57,281	195,286	12,981	4,620,372	5,086,928	1.10	133	8,050
Other counties[a] and small mines	730,657	229,025	47,370	....	1,007,052	1,589,954	1.54	150	2,522
Total	41,818,730	2,666,614	1,400,352	14,550	45,900,246	52,405,897	1.14	160	72,645

a Bond, Calhoun, Greene, Hancock, Jefferson, McLean, Morgan, Moultrie, Putnam, Schuyler, Scott, Warren, Washington, White, Will, and Woodford.

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 1910 as compared with 1909:

Coal production of Illinois, 1906–1910, by counties, in short tons.

County.	1906	1907	1908	1909	1910	Increase (+) or decrease (—), 1910.
Bond	132,325	138,990	60,129	89,861	139,398	+ 49,537
Bureau	1,580,085	2,010,762	1,512,971	1,612,452	973,346	— 639,106
Calhoun	5,045	2,850	3,521	....	....	....
Christian	934,452	1,368,159	1,377,166	1,395,158	1,223,295	— 171,863
Clinton	515,796	1,302,391	1,078,848	970,709	950,243	— 20,466
Franklin	....	1,306,966	2,187,383	2,316,509	1,778,768	— 537,741
Fulton	1,579,224	2,113,643	2,012,415	2,388,617	1,721,527	— 667,090
Gallatin	92,731	78,055	59,667	64,713	70,091	+ 5,378
Greene	2,206	2,310	9,506	7,318	9,082	+ 1,764
Grundy	1,162,019	1,327,321	1,081,442	1,114,101	600,281	— 513,820
Hamilton	....	....	(a)	....	....	....
Hancock	4,498	2,034	1,406	1,085	640	— 445
Henry	149,188	149,721	141,624	137,060	124,243	— 12,817
Jackson	646,196	645,333	624,055	652,280	584,240	— 68,040

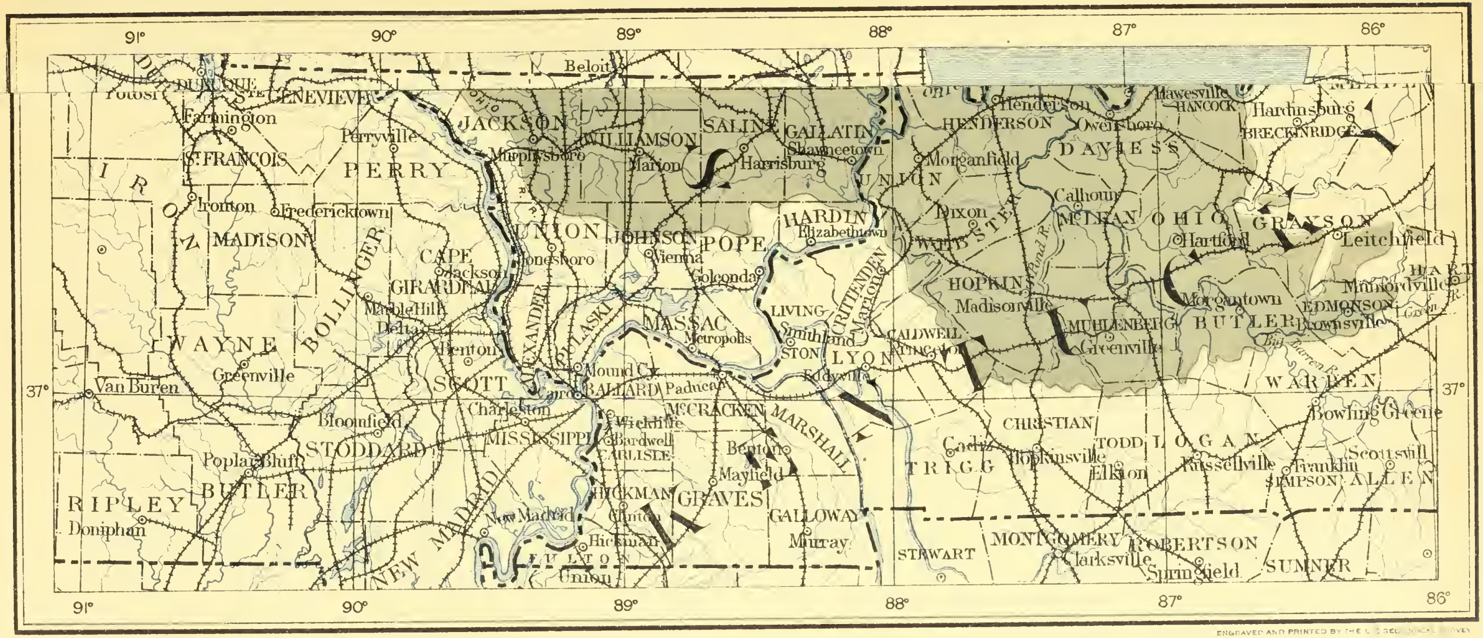
a Included with production of Hancock County.

Coal production of Illinois, 1906–1910, by counties, in short tons—Continued.

County.	1906	1907	1908	1909	1910	Increase. (+) or decrease (−) 1910.
Jefferson	7,600	12,000	18,675	4,800	10,000	+ 5,200
Jersey	1,397	1,162	1,496	1,000	....	− 1,000
Kankakee	39,499	26,704	30,994	25,000	....	− 25,000
Knox	51,654	40,996	41,040	21,973	28,295	+ 6,322
La Salle	1,467,672	1,677,990	1,557,173	1,686,391	1,178,885	− 507,506
Livingston	273,831	303,497	265,666	246,031	162,898	− 83,133
Logan	435,559	477,115	372,980	395,888	409,244	+ 13,356
McDonough	43,774	32,199	17,818	16,276	26,338	+ 10,062
McLean	145,000	151,146	95,854	116,412	83,982	− 32,430
Macon	292,884	269,766	235,237	238,607	235,631	− 3,246
Macoupin	3,637,827	4,507,270	3,894,199	4,597,775	3,854,229	− 743,546
Madison	3,324,857	3,927,721	3,367,820	3,373,798	4,102,773	+ 728,975
Marion	1,042,866	1,185,533	981,284	1,171,950	812,873	− 359,077
Marshall	418,904	482,796	393,281	295,812	267,447	− 28,365
Menard	429,971	389,918	355,309	303,948	332,557	+ 28,609
Mercer	412,165	453,621	376,435	369,762	229,024	− 140,738
Montgomery	720,415	1,289,021	1,410,978	1,780,668	1,799,720	+ 19,052
Morgan	9,100	5,513	3,244	1,200	1,300	+ 100
Peoria	914,863	1,103,312	921,929	914,961	810,595	− 104,366
Perry	1,509,716	1,784,469	1,576,891	1,423,135	1,367,771	− 55,364
Putnam	156,928	362,858	466,019	597,703	364,882	− 232,821
Randolph	634,270	824,761	751,605	799,893	1,025,557	+ 225,664
Rock Island	62,321	52,938	50,781	46,228	66,207	+ 19,979
St. Clair	4,904,811	4,511,879	3,696,017	3,471,630	5,788,567	+ 2,316,937
Saline	980,864	2,247,842	2,552,137	3,283,939	2,459,650	− 824,280
Sangamon	4,543,849	5,160,042	5,015,608	5,616,357	4,449,634	− 1,166,723
Schuyler	3,090	7,553	15,269	4,573	2,427	− 2,146
Scott	12,437	17,639	3,427	2,056	2,400	+ 344
Shelby	138,257	155,930	181,373	124,087	135,672	+ 11,585
Stark	17,661	25,897	20,351	23,159	32,582	+ 9,423
Tazewell	189,882	235,971	206,882	208,049	155,659	− 52,390
Vermilion	2,389,285	2,973,253	2,452,485	1,919,955	2,515,250	+ 595,295
Warren	9,520	9,139	11,687	12,304	10,275	− 2,029
Washington	85,812	29,000	72,500	31,322	22,500	− 8,822
White	8,000	16,453	19,583	22,133	23,722	+ 1,589
Will	154,955	183,985	162,239	162,307	124,652	− 37,655
Williamson	4,417,987	5,697,944	5,670,474	6,537,654	4,620,372	− 1,917,282
Woodford	[a] 717,566	[b] 158,742	[c] 174,031	194,410	125,823	− 68,587
Small mines	69,299	75,036	68,786	[d] 111,981	85,969	− 26,012
Total	41,480,104	51,317,146	47,659,690	50,904,990	45,900,246	− 5,004,744
Total value	$44,763,062	$54,687,382	$49,978,247	$53,522,014	$52,405,897	−$1,116,117

[a] Includes production of Franklin County.
[b] Includes production of Wabash County.
[c] Includes production of Edgar and Moultrie counties.
[d] 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 Crevecœur, 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 boatloads 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. 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



COAL FIELDS OF ILLINOIS, INDIANA, AND WESTERN KENTUCKY

Scale $\frac{1}{2500000}$

25 0 25 50 75 100 Miles

1911

ENGRAVED AND PRINTED BY THE U. S. GEOLOGICAL SURVEY

COAL FIELDS OF ILLINOIS, INDIANA, AND WESTERN KENTUCKY

Scale $\frac{1}{2500000}$

25 0 25 50 75 100 Miles

1911

found in the geologic reports published by the State government. The production of coal in Illinois from 1833 to the close of 1910 is shown in the following table:

Production of coal in Illinois, 1833–1910, 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	1910	45,900,246
1851	320,000	1871	3,000,000	1891	15,660,698		
1852	340,000	1872	3,360,000	1892	17,862,276	Total.	790,333,235

THE COAL FIELDS OF ILLINOIS.[1]

The Illinois coal fields (Pl. IV) are included in the eastern interior region, which contains also the Indiana and the western Kentucky coal fields. Nearly three-fourths of the State is underlain by productive coal measures, the total area being estimated at 35,600 square miles. They have generally been supposed to contain a larger coal-bearing area than any other State in the Union, but more definite knowledge may show the coal fields of North Dakota or Montana to exceed those of Illinois.

Structurally the Illinois coal fields comprise the western part of a broad and relatively flat basin. A narrow and low, though sharply defined, anticline extends from La Salle, on the northern border of the fields, southeastward toward Clark County. Toward the southwest the beds turn up perceptibly at the border of the field, while the southern margin is marked by a steeper fold which becomes overturned and faulted before reaching Shawneetown, where it crosses the river into Kentucky. Minor folds, local in extent, occur in different parts of the basin, but in general the beds slope very gently from the margin of the field to the central deep area, where the Pennsylvanian has a thickness of about 1,500 feet.

Mining developments are scattered somewhat unevenly from Grundy County, on the northern margin of the field, all the way through the western half of the region and eastward to the Kentucky line, across the southern tier of counties. A somewhat isolated mining region, including a limited number of operations near Danville, lies in Vermilion County, at the eastern border of the State. Besides the Danville region, other well-known mining centers are the Mazon Creek region of Livingston and Grundy counties, the Streator-Spring Valley district, the Peoria region, the Springfield-Belleville belt, and the

[1] See map of coal fields of Illinois, Indiana, and western Kentucky.

extension of the latter through Washington, Perry, Franklin, and Williamson counties to the Harrisburg district in Saline County.

The coals of Illinois have not yet been studied with sufficient stratigraphic detail in all areas to justify a final statement as to their probable correlation and extent. The revival of the State Geological Survey in 1905 and the work already done by it in cooperation with the United States Geological Survey is placing our knowledge of the coal beds on a much more exact basis in those areas which have been topographically mapped and geologically studied in detail. The territory which has so far been covered by detailed geologic surveys comprises six quadrangles forming a row across the southern end of the State from Murphysboro to New Haven, the Belleville and Breese quadrangles east of St. Louis, the Tallula and Springfield quadrangles in the central part of the State, the Peoria quadrangle in the western part, the La Salle and Hennepin quadrangles in the northern part, and the Danville quadrangle in the eastern part of the State. A folio text descriptive of the last-named quadrangle was several years ago issued by the United States Geological Survey, and texts, with maps, relating to the other enumerated quadrangles are now in preparation and will be issued later. Shorter contributions, mainly economic in character, giving particular attention to the character of the coals, have been published by the State Geological Survey. A considerable amount of reconnaissance work has also been done along the western and the southern borders of the coal field and in connection with the study of the oil and gas phenomena in the eastern part of the coal field near the Indiana line.

The stratigraphic studies of the coal beds have resulted in a number of correlations, some of which are worthy of mention. Thus, it has already been shown that the coal known as the No. 5 in southeastern Illinois corresponds to coal No. 9 of western Kentucky, where apparently it is the principal bed worked over most of the western Kentucky coal field. It appears probable also that it is identical with coal No. V, the main bed of southern Indiana. In Illinois coal No. 5 is best known to the trade as the Springfield or Peoria coal. In the same way it has been shown that the coal bed generally known as No. 7 of southeastern Illinois is identical with coal No. 6, the Belleville bed, of southwestern Illinois. This coal, frequently known as the "Blueband" coal on account of the character and persistence of a thin shale parting over most of its area, has in recent years been very extensively developed in Williamson and Franklin counties, the high-grade fuel produced by the mines in this area being sometimes known as the Williamson or Herrin coal. The same bed has been traced into western Kentucky and correlated with No. 11 of the latter area.

The reconnaissance work in paleobotany carried on by David White in the Illinois coal fields shows that coal No. 1 along the western margin of the fields lies in the upper Pottsville at or below the horizon of the Mercer group of coals. In the southern part of the State there are, however, several locally workable coals which are older and underlie the horizon of coal No. 1. Some of these coals were recognized in the western Kentucky coal field and were mapped and numbered by the Geological Survey of Kentucky. This fact explains the difference between the numbers used by the Illinois and the Kentucky geologists in their respective fields. Of the important coals in Illinois the lowest is that known as coal No. 2. It is the Murphysboro bed, which formerly was the source of the fuel known in the market as Big Muddy coal. The same bed was worked at Colchester and at other points farther north in the State. It is supposed to be equivalent to the "No. 2" coal in the region of Grundy County in northern Illinois. It is possible that the coal, No. 2, of Grundy County may not be the exact equivalent of the Colchester (Murphysboro) bed, but presumably it is the same. In the older mines of La Salle, Bureau, and Putnam counties, in the northern part of the State, where the bed is extensively mined, coal No. 2, because it is the third workable bed encountered in the deeper shafts, has long been known as the "third vein," and its well-known fuel is marketed as "third vein" coal. Coal bed No. 2, though rarely of great thickness, is remarkably persistent and even in structure, and is worked here and there along its outcrop nearly all the way from the Indiana line to the region of St. Louis. It is locally workable also along the southern border of the field. This bed, which is probably referable to the horizon of the Clarion coal group in Pennsylvania, has been made the base of the recently established Carbondale formation, the topmost member of which is the No. 6 coal. The Carbondale formation falls within and is probably nearly equivalent to the Allegheny formation of the Appalachian trough. The so-called "second vein" of some of the mines in the northern part of the State probably represents coal No. 5, which is well developed and extensively exploited in a large region including Peoria and Springfield.

In the Danville district in Vermilion County two beds of coal from 20 to 80 feet apart are worked. The lower of these, known as the Grape Creek bed, is tentatively correlated with coal No. 6, while the upper, the Danville, bed is known as No. 7. These coals are mined to a depth of nearly 250 feet. The "first vein" encountered in the shaft near La Salle is supposed to represent the Danville coal. It lies about 50 feet above coal No. 5, which in turn is 150 feet or more above coal No. 2 (the "third vein").

The Illinois coal beds are more regular in thickness than most of those in the Appalachian trough, and they are far more regular and persistent than the Pottsville coals of the southern Appalachian region. On account of its good grade and its generally excellent roof, coal No. 2 is worked by shafts of considerable depth locally to a thickness of not over 2½ feet. The Kewanee coal, provisionally correlated with coal No. 6, is worked in a thickness of 4 feet and at a depth of 100 feet in Henry County, and in a thickness locally reaching 6 feet and at depths not exceeding 130 feet in Stark County. The Peoria bed, correlated as No. 5, underlies most of Stark County in an average thickness of about 4½ feet. Coal No. 2 also has been mined as far out in the basin as Peoria. There it is said to be 4 feet in thickness. Another coal, regarded by many as coal No. 1, is said to have disclosed a thickness of 3 feet at a depth of 235 feet below the river bottoms near Peoria. In Rock Island and Mercer Counties coal No. 1, 2½ to 4½ feet thick, is worked at shallow depths. In Menard and Sangamon counties, where coal No. 5 is extensively exploited, the bed attains a thickness of 6 feet and lies at depths of less than 300 feet. In this part of the State coals No. 6 and No. 8, and two or three beds below No. 5, are reported to range from 1 to 3 feet in thickness, but they are not now worked.

Coal No. 6, the "Blue Band" or "Belleville" coal, is typically developed through a large area in the western part of the State, bounded roughly by Mississippi River on the west, and a curve drawn on a radius extending 75 miles north from St. Louis. In this region the bed, which ranges from 5½ to 7 feet in thickness, the average being over 6 feet, is mined at depths varying from 50 to 800 feet, the depth increasing in general to the east. So far as is known, this coal bed is the thickest, most persistent, and most regular bed of coal in the State. There are only a few small districts in the area above described in which the coal is absent, and, indeed, only a few in which it is less than 5 feet thick. It is best known in the region of Belleville, from which it takes its name. From this point it extends eastward to Centralia, and southeastward to Duquoin and Marion. At Duquoin the bed averages about 6 feet in thickness, while in many of the mines of Williamson County, where the fuel is known as the Herrin coal, it reaches a thickness of over 9 feet. In the northern half of this county the bed is mined at depths ranging up to 150 feet. In this region the coal is over areas of considerable size, remarkably free from sulphur, the percentage falling to 0.7.

In Williamson County, coal No. 5, less than 100 feet below No. 6, is but little inferior in quality, and is in workable thickness, though it does not present the large body of easily mined fuel found in No. 6, from which the great output of the county is now obtained.

At Harrisburg a valuable coal, which is thought to be No. 5, is extensively worked from outcrops or by shafts ranging to a depth of 150 feet. Several coals of minor importance, but locally workable, are present throughout the southern part of the State.

In the eastern part of Illinois is a large area in which at present there is no mining, but in which the evidence indicates important coal reserves, which in time will prove very valuable.

Recent analyses of Illinois coals show them to contain an average of about 12 per cent of moisture, 10 per cent of ash, 37 per cent of volatile matter, 39 per cent of fixed carbon, and 3 per cent of sulphur. Naturally, the proportions of these constituents vary from region to region, and even from mine to mine.

On account of the generally flat topography of the country and the thick mantle of drift over most of the State, the exploitation in the field is mostly by shaft mines. The deepest of these, at Assumption, in Christian County, is nearly 1,000 feet. Some of the shafts are, however, less than 50 feet in depth, the average being probably less than 250 feet. The shafts are, as a rule, well equipped with self-dumping cages, using large cars, or with double-track cages hoisting two small cars at a time. The room-and-pillar method largely prevails, but some of the thinner coals, particularly No. 2 in the northern part of the field, are locally worked by the long-wall method. In the long-wall region the rock refuse hoisted equals 10 or 15 per cent of the mined coal. Machine mining has not made the progress in this State that it has in some others on account of the small mining machine differential. The majority of the mines are dry, requiring little or no pumping, and most of the deep mines require frequent sprinkling. Mine cars carry from 1 ton to 3½ tons, and as the dip is usually low and haulage easy, mechanical haulage has been introduced but slowly, tail rope and electric motors being used. Although a majority of the hoists are second motion, practically all of the larger new mines use first-motion engines. Tipples are well built, most of the new ones being of steel. They are usually well equipped with shaking screens, and at some of the mines the screenings are washed and rescreened. As a rule, the coal is weighed run of mine. The product is distributed throughout Illinois, eastern Iowa, southern Wisconsin, and Minnesota, and south along both sides of the Mississippi to the Gulf. Chicago is naturally the largest market.

The production of coal in Illinois since 1833 will be found in the table on a preceding page giving the history of coal production in the United States from the earliest times to the close of 1910.

According to Mr. Campbell's estimate,[1] the original coal supply of Illinois when mining began was 240,000,000,000 short tons, all bituminous, and contained within a total area of 35,600 square miles. The total production of the State at the close of 1910, as far as records are obtainable, amounted to 790,333,235 tons, which, with a half-ton wasted for every ton mined, is equivalent to a total exhaustion of 1,185,500,000 short tons, from which it appears that the exhaustion to the close of 1910 was about 0.5 of 1 per cent of the total estimated supply.

In the following table the total number of mines, the percentage of mines, the total production in tons, and the percentage of the total production is given for each of the commercially productive coal beds of the State in 1909. The mines are grouped into five classes: First, those producing over 200,000 tons annually; second, 100,000 to 200,000 tons; third, 50,000 to 100,000 tons; fourth, 10,000 to 50,000 tons; fifth, less than 10,000 tons per annum. It will be seen that in each of these classes or groups of mines the largest number by far were operated in coal No. 6, the next greatest number being in coal No. 5. In every class except the fifth, coal No. 2 was third in rank both as to the number of mines and as to production. In the fifth class, embracing mines of less than 10,000 tons production, the total production of coal No. 7 exceeded that of coal No. 2, and coal No. 1, fifth in importance, had a production less than 10,000 tons below that of coal No. 7. It will be noted on consulting the summary that 271, or 45.4 per cent, of the shipping mines in the State were operated in coal No. 6 and that these mines produced 28,547,675 tons, or 56.5 per cent of the total output of Illinois coal. In coal No. 5, 29.1 per cent of the total number of mines in the State produced 26.5 per cent of the total output. Coals No. 2 and No. 7 produced 11 per cent and 5 per cent, respectively, of the total output, while the production from coal No. 1, the percentage of mines being 4.7, was but 1 per cent.

[1] Campbell, M. R. Coal fields of the United States, U. S. Geol. Survey, 1908.

Coal production of Illinois in 1909, according to beds and to importance of mines, in short tons.[a]

Bed.	First class.					Second class.				
	Mines.		Production.			Mines.		Production.		
	Number.	Percentage.	Total.	Average per mine.	Percentage.	Number.	Percentage.	Total.	Average per mine.	Percentage.
No. 1	......	......	......	......	......	3	11	345,582	115,194	64
No. 2	10	14	2,464,825	246,485	45	15	20	2,109,821	140,655	39
No. 3	......	......	......	......	......	......	......	......	......	......
No. 5	22	13	7,239,527	329,069	54	21	12	3,111,670	143,412	23
No. 6	60	22	19,360,566	322,676	68	36	13	5,117,248	142,146	18
No. 7	5	11	1,479,310	295,862	58	3	7	352,511	117,504	14
Strippings	......	......	......	......	......	......	......	......	......	......
Total	97	16	30,544,228	314,889	60	78	13	11,036,832	141,498	22

Bed.	Third class.					Fourth class.				
	Mines.		Production.			Mines.		Production.		
	Number.	Percentage.	Total.	Average per mine.	Percentage.	Number.	Percentage.	Total.	Average per mine.	Percentage.
No. 1	1	3	59,758	59,758	11	3	11	65,261	21,754	12
No. 2	7	10	540,257	77,179	10	9	12	274,822	30,536	5
No. 3	......	......	......	......	......	......	......	......	......	......
No. 5	23	13	1,763,051	76,654	13	39	23	1,046,414	26,831	8
No. 6	32	12	2,324,362	72,652	8	53	20	1,412,225	26,646	5
No. 7	5	11	371,720	74,355	15	8	18	240,003	30,000	10
Strippings	......	......	......	......	......	......	......	......	......	......
Total	68	11	5,059,648	74,407	10	112	19	3,038,725	27,131	6

Bed.	Fifth class.					Total.				
	Mines.		Production.			Mines.		Production.		
	Number.	Percentage.	Total.	Average per mine.	Percentage.	Number.	Percentage.	Total.	Average per mine.	Percentage.
No. 1	20	77	67,121	3,356	13	27	4.7	537,722	19,916	1.0
No. 2	32	44	76,585	2,393	1	73	12.2	5,466,310	74,881	11.0
No. 3	3	100	8,847	2,949	100	3	.5	8,847	2,949	......
No. 5	69	39	267,121	3,871	2	174	29.1	13,427,783	77,171	26.5
No. 6	90	33	332,774	3,697	1	271	45.4	28,547,675	105,342	56.5
No. 7	24	53	85,683	3,570	3	45	7.5	2,529,227	56,205	5.0
Strippings	4	100	11,806	2,951	100	4	.6	11,806	2,951	......
Total	242	41	849,937	3,512	2	597	100.0	50,529,370	84,639	100.0

[a] First class, production over 200,000 tons; second class, production 100,000 to 200,000 tons; third class, production 50,000 to 100,000 tons; fourth class, production 10,000 to 50,000 tons; fifth class, production less than 10,000 tons.

INDIANA.

Total production in 1910, 18,389,815 short tons; spot value, $20,813,659.

Some of the coal miners of Indiana suspended work in sympathy with the strike in Illinois and in the Southwestern States, but the idleness in Indiana was not general nor was it by any means so prolonged as in the other States affected. Of the total number of men employed in the coal mines of Indiana only about 60 per cent quit work on the strike call and these remained idle for an average of but 34 days, whereas in the other fields the idleness extended from April 1 to September 15, and the effects lasted for fully six months. Indiana operators and miners benefited accordingly from the strike, as is shown by an increase in production from 14,834,259 short tons in 1909 to 18,389,815 short tons in 1910, a gain of 3,555,556 tons, or 24 per cent. Moreover, on account of the fuel shortage occasioned by the strike, the prices for Indiana coal advanced, the average in 1910 being $1.13 per short ton against $1.02 in 1909, and the total value of the coal produced increased $5,658,978, or 37.34 per cent, from $15,154,681 in 1909 to $20,813,659 in 1910.

The largest increases in 1910 were in the two counties Greene and Sullivan, which have been the districts of active development during the last few years. Nearly one-half of the total increase of the State in 1910 was from these counties, Greene County having shown a gain of 826,316 tons and Sullivan of 808,419 tons. Vigo County also showed the substantial gain of 619,265 tons, and Knox County increased its production 361,182 tons, or nearly 60 per cent. The increase in Knox County in 1910 was more than the total production of the county five years before. A similar percentage of gain was made by Warrick County, the increase in output being 280,512 tons; Pike County gained 250,263 tons and Vermilion County nearly 200,000 tons.

Of the total production of 18,389,815 short tons in 1910, 8,986,495 tons, or nearly 50 per cent, was mined by machines, of which there were 645 in use. In 1909, 631 machines were employed in mining 7,408,829 tons of coal. Machines of the chain-breast pattern appear to be preferred in the mines of Indiana, since of the 645 machines in use in 1910, 422 were of that type. These included a few ''short-wall'' or ''continuous-cutter'' machines, in which the principle of the cutting bits affixed to an endless chain is maintained as in the chain-breast machine. Of the other 223 machines, 194 were of the pick or puncher type, and 29 were long-wall.

The coal mines of Indiana gave employment in 1910 to 21,878 men, who, notwithstanding the average of 34 days lost by 12,638 men on strike, made an average of 229 working days. This was 32 days better in working time than in the boom year 1907, and is the best record made in the history of Indiana coal mining. The average production per man was also a record breaker, the average for 1910 being 841 tons to each employee for the year and 3.67 tons for each working day. Average daily production per man in previous years (the statistics for 1909 not being available) were, 1908, 3.85 tons; 1907, 3.38 tons; 1906, 3.3 tons. The best previous yearly average was 665 tons per man, made in 1907. With a few unimportant exceptions the coal mines of Indiana work 8 hours a day.

The statistics of coal production in Indiana in 1909 and 1910, by counties, with the distribution of the product for consumption, are shown in the following table:

Coal production of Indiana in 1909 and 1910, by counties, in short tons.

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.
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

1910.

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.
Clay	919,375	36,948	23,693	....	980,016	$1,364,759	$1.39	220	1,727
Daviess	56,680	27,680	3,014	....	87,374	120,564	1.38	205	228
Dubois and Martin	....	6,950	1,340	....	8,290	11,260	1.36	231	14
Fountain and Warren	....	8,322	100	....	8,422	16,524	1.96	210	24
Gibson	269,215	24,355	3,183	....	296,753	336,346	1.13	252	781
Greene	3,313,466	45,941	79,595	....	3,439,002	3,841,530	1.12	241	3,570
Knox	970,770	15,884	17,255	....	1,003,909	1,005,955	1.00	233	870
Owen	1,600	8,950	140	....	10,690	15,780	1.48	125	31
Parke	712,078	28,481	23,556	....	764,115	1,054,914	1.38	214	1,265
Perry	600	25,415	302	....	26,317	34,826	1.32	211	47
Pike	653,166	37,044	7,175	....	697,385	802,571	1.15	225	918
Spencer	989	8,105	2	....	9,096	12,927	1.42	165	22
Sullivan	3,909,097	39,494	87,343	....	4,035,934	4,496,172	1.11	223	4,202
Vanderburg	120,114	261,340	16,839	....	398,293	418,902	1.05	236	426
Vermilion	1,585,821	25,552	24,250	....	1,635,623	1,707,723	1.05	214	1,767
Vigo	3,996,910	95,568	89,321	....	4,181,799	4,733 292	1.13	236	5,185
Warrick	716,253	37,608	14,845	....	768,706	788,504	1.03	222	801
Small mines	....	38,091	....	....	38,091	51,110	1.34	....	....
Total	17,226,134	771,728	391,953	....	18,389,815	20,813,659	1.13	229	21,878

In the following table is shown the production of coal in Indiana, by counties, during the last five years, with increase and decrease in 1910 as compared with 1909:

Coal production of Indiana, 1906–1910, by counties, in short tons.

County.	1906	1907	1908	1909	1910	Increase (+) or decrease (—), 1910.
Clay	1,101,228	1,266,507	863,649	958,732	980,016	+ 21,284
Daviess	135,985	120,996	77,034	73,877	87.374	+ 13,497
Dubois	a 14,700	a 8,460	a 12,320	a 35,404	a 8,290	— 27,114
Fountain	b 84,469	b 41,270	....	5,520	3,300	— 2,220
Gibson	142,444	207,472	188,500	232,599	296,753	+ 64,154
Greene	2,307,486	2,773,944	2,361,404	2,612,686	3,439,002	+ 826,316
Knox	333,833	374,099	428,821	642,727	1,003,909	+ 361,182
Owen	....	....	....	15,904	10,690	— 5,214
Parke	707,027	655,312	644,062	730,082	764,115	+ 34,033
Perry	13,261	17,965	10,601	15,603	26,317	+ 10,714
Pike	497,957	516,418	460,180	447,122	697,385	+ 250,263
Spencer	19,256	25,916	13,206	11,118	9,096	— 2,022
Sullivan	2,415,847	2,897,840	2,602,543	3,227,515	4,035,934	+ 808,419
Vanderburg	302,919	317,371	263,171	271,644	398,293	+ 126,649
Vermilion	1,342,478	1,442,103	1,142,802	1,443,099	1,635,623	+ 192,524
Vigo	2,197,459	2,724,743	2,735,399	3,562,534	4,181,799	+ 619,265
Warren	....	....	4,800	7,130	5,122	— 2,008
Warrick	447,995	568,522	482,613	488,194	768,706	+ 280,512
Small mines	28,216	26,775	23,785	52,769	38,091	— 14,678
Total	12,092,560	13,985,713	12,314,890	14,834,259	18,389,815	+ 3,555,556
Total value	$13,116,261	$15,114,300	$13,084,297	$15,154,681	$20,813,659	+$5,658,978

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 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 nearly trebled in 1910.

The statistics of coal production in Indiana from 1840 to the close of 1910 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 1910, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1840	9,682	1859	95,000	1878	1,000,000	1897	4,151,169
1841	10,000	1860	101,280	1879	1,196,490	1898	4,920,743
1842	18,000	1861	128,000	1880	1,454,327	1899	6,006,523
1843	25,000	1862	150,000	1881	1,984,120	1900	6,484,086
1844	30,000	1863	200,000	1882	1,976,470	1901	6,918,225
1845	35,000	1864	250,000	1883	2,560,000	1902	9,446,424
1846	40,000	1865	280,000	1884	2,260,000	1903	10,794,692
1847	45,000	1866	320,000	1885	2,375,000	1904	10,842,189
1848	50,000	1867	350,000	1886	3,000,000	1905	11,895,252
1849	56,000	1868	375,000	1887	3,217,711	1906	12,092,560
1850	60,000	1869	400,000	1888	3,140,979	1907	13,985,713
1851	60,000	1870	437,870	1889	2,845,057	1908	12,314,890
1852	75,000	1871	600,000	1890	3,305,737	1909	14,834,259
1853	75,000	1872	896,000	1891	2,973,474	1910	18,389,815
1854	80,000	1873	1,000,000	1892	3,345,174		
1855	80,000	1874	812,000	1893	3,791,851	Total.	204,979,354
1856	85,000	1875	800,000	1894	3,423,921		
1857	85,000	1876	950,000	1895	3,995,892		
1858	87,000	1877	1,000,000	1896	3,905,779		

Mr. Campbell's estimate regarding the coal fields of Indiana placed the original supply at 44,169,000,000 short tons. The aggregate production of coal in Indiana, to the close of 1910, amounted to 204,979,354 short tons, of which 18,389,815 tons, or practically 9 per cent, were produced in 1910. Mr. Campbell estimates the exhaustion represented by this production at 300,000,000 tons, or 0.68 of 1 per cent of the estimated original supply.

THE COAL FIELDS OF INDIANA.[1]

The eastern edge of the eastern interior coal region extends over the southwest portion of Indiana, including an area of 6,500 square miles distributed through 26 different counties, in 18 of which at present coal is produced on a commercial scale. All of the coal mined in Indiana is classed as bituminous. That along the eastern edge of the field is of Pottsville age and is known as block or semi-block coal. It is very pure, dry, and noncoking, and derives its name from the almost perfectly rectangular blocks into which it breaks, because of the pronounced cleavage planes which intersect each other nearly at right angles. The rest of the coal, distinguished locally as "bituminous," is classed as coking and gas coal, though it is not of sufficiently high grade to compete for those uses with the high-grade coking and gas coals of the Eastern States. As a steam coal it competes successfully with the Appalachian coals, according to the geographic position of the market. Cannel coal is successfully mined at one or two points.

Coal has been found in at least 20 different horizons, and as many as 17 beds have been passed through in a single drilling in a vertical distance of 800 feet. Most of these are thin, but beds of sufficient thickness to be worked are found at 8 different horizons. At present the commercial coal is obtained from 6 horizons. The lower block coals which outcrop along the outer or eastern edge of the region occur in basins, some of which are but a few acres in area. In many of these basins the coal is several feet thick in the center of the basin, and thins to a few inches on the edges. The coal beds are supposed to lie at definite horizons; they are generally continuous from basin to basin; and they present the same characteristics of roof, floor, partings, and qualities of fuel over great areas. The coal in the block-coal areas runs from 2 to 5 feet in thickness, averaging about 3 feet 6 inches.

The upper or so-called "bituminous" beds show remarkable persistency over large areas. In many cases the different beds have striking peculiarities that readily differentiate them and permit them to be traced with certainty over several thousands of square miles. The horizons of the principal beds are believed to have been continuously traced entirely across that portion of the eastern interior region lying in this State. The upper coals range from 3 to 10 feet in thickness, and the majority of the mines have coal 5 or more feet in thickness, 26 of the large mines having 7 or more feet of coal. In over 90 per cent of the mines there is a clay floor, and in a still larger percentage there is a shale roof. Taking the coal field as a whole there are considerable areas which do not contain any workable coal; on the other hand, a large part of the field is underlain by more than

[1] See map (Pl. IV) of coal fields of Illinois, Indiana, and western Kentucky accompanying the description of the coal fields of Illinois.

one workable bed. A number of mines work as many as three beds. Parts of the field are underlain by about 20 feet of workable coal.

Nearly all of the commercial mines reach the coal by shafts at depths of from 50 to 450 feet, though there are a few that enter the beds by slope and still fewer by drift. As a whole, the mines are well equipped with modern machinery, including mining machines (in which the electric chain machines are in the large majority), electric motors, self-dumping cages, shaking screens, box-car loaders, etc.

For stratigraphic information and correlations of the coal measures in the Indiana region the reader is referred to the Thirty-third Annual Report of the Geological Survey of Indiana for 1908 and to Bulletin 381 of the United States Geological Survey, 1910, pages 9–18.

IOWA.

Total production in 1910, 7,928,120 short tons; spot value, $13,903,913.

The benefit derived by Iowa coal operators from the strike in the Illinois field was principally in eliminating the competition of Illinois coal from the comparatively local markets, which are naturally tributary to the Iowa mines. Coal operators in Iowa have complained that Illinois coals have more favorable freight rates than those accorded to the Iowa product and that mining rates originally fixed to compensate differences in freight charges have not been changed with reduced freights on Illinois coal and that the Iowa mines have been placed at a disadvantage accordingly. The statistics for 1909 indicated an improvement in these conditions, for the production was the largest in the history of the State and prices were the highest in recent years. The idleness in Illinois in 1910 reacted upon Iowa production more in the way of still higher prices than by any marked increase in production. Apparently the only reason assignable for the comparatively small increase is that the mines were operated to the full capacity with the available supply of labor. That there was no exodus from the Illinois mines to those of Iowa is shown by the fact that there were fewer men employed in the Iowa mines in 1910 than in 1909. There were some strikes, but they were not as protracted as in Illinois, and the total time lost was only about 10 per cent of the time worked. The general strike, which began on April 1, lasted in Iowa about six weeks, whereas in Illinois it lasted practically six months.

Compared with 1909 the coal production of Iowa in 1910 showed an increase of 170,358 short tons, or 2.2 per cent, in quantity, and of $1,110,285, or 8.68 per cent, in value, the figures for the two years being, respectively, 7,757,762 and 7,928,120 short tons in quantity and $12,793,628 and $13,903,913 in value.

Coal was mined in 22 counties of Iowa in 1909 and 1910, production in 1910 showing increase and decrease in the same number of counties. The largest increase was shown in Appanoose and Monroe Counties, the former exhibiting a gain of 177,887 tons and the latter of 158,471 tons. Marion County reported the largest decrease, 114,072 tons, and Mahaska County, second in this regard, showed a decrease of 77,239 tons. The changes in the other 18 counties, both for increase and decrease, were of minor importance.

The Iowa coal mines gave employment in 1910 to 16,666 men, who worked an average of 218 days. Of the 16,666 men employed 9,209 were on strike during the year, the average period of idleness being 44 days. The average production per man was 476 tons for the year and 2.18 tons for each working day. In 1908, when 16,021 men were employed in the production of 7,161,310 short tons, the average output per man was 447 tons for the year and 2.09 tons for each working day. Most of the mines of the State are operated 8 hours a day.

Mining machines were used in but 2 mines in Iowa during 1910, and the number of machines in operation was 17. In 1909 only 1 mine reported having any machines in use. Eleven of the machines reported in 1910 were punchers and 6 were of local type, the Lee "cutter-bar." The machine-mined product in 1910 amounted to 22,158 short tons against 7,500 tons in 1909.

The statistics of coal production in Iowa in 1909 and 1910, by counties, with the distribution of the product for consumption, are shown in the following table:

Coal production of Iowa in 1909 and 1910, by counties, in short tons.

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[a] 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

1910.

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	100	12,615	30	12,745	$34,706	$2.72	175	42
Appanoose	1,344,843	54,497	14,556	1,413,896	2,813,578	1.99	200	4,578
Boone	237,479	27,198	11,205	275,882	550,178	1.99	222	762
Dallas	245,255	5,510	4,320	255,085	447,817	1.76	210	530
Greene	600	9,300	250	10,150	26,175	2.58	183	47
Guthrie	....	17,324	....	17,324	53,665	3.10	185	27
Jasper	334,966	14,087	10	349,063	740,132	2.12	228	718
Keokuk	800	11,841	500	13,141	25,443	1.94	219	30
Mahaska	787,714	36,365	24,120	848,199	1,131,408	1.33	229	1,583
Marion	190,520	21,766	2,995	215,281	348,992	1.62	198	599
Monroe	2,079,205	48,567	56,258	2,184,030	3,506,140	1.61	238	3,401
Polk	1,536,133	193,406	48,725	1,778,264	3,140,598	1.77	217	3,022
Taylor	5,622	4,092	35	9,749	24,233	2.49	154	47
Van Buren	5,000	5,152	132	10,284	23,960	2.33	215	21
Wapello	234,963	44,298	4,239	283,500	498,210	1.76	236	599
Wayne	125,926	9,453	60	135,439	280,100	2.07	230	402
Webster	39,913	8,707	1,353	49,973	111,720	2.24	169	183
Other counties[b] and small mines	....	64,693	1,422	66,115	146,858	2.22	193	75
Total	7,169,039	588,871	170,210	7,928,120	13,903,913	1.75	218	16,666

[a] Dallas, Jefferson, Lucas, and Scott.

[b] Jefferson, Lucas, Page, Scott, and Warren.

The production by counties during the last five years, with increase and decrease in 1910 as compared with 1909, is shown in the following table:

Coal production of Iowa, 1906–1910, by counties, in short tons.

County.	1906	1907	1908	1909	1910	Increase (+) or decrease (−), 1910.
Adams	11,724	14,343	17,492	13,194	12,745	− 449
Appanoose	1,101,595	1,123,409	1,144,405	1,236,009	1,413,896	+ 177,887
Boone	233,110	208,150	237,498	275,711	275,882	+ 171
Dallas	5,522	70,042	174,585	244,219	255,085	+ 10,866
Davis	....	1,300	3,700	....	....	....
Greene	19,816	16,289	15,431	9,700	10,150	+ 450
Guthrie	....	....	....	6,730	17,324	+ 10,594
Jasper	388,582	397,297	393,516	323,092	349,063	+ 25,971
Jefferson	3,744	4,000	3,500	6,255	7,530	+ 1,275
Keokuk	17,144	27,716	18,301	14,430	13,141	− 1,289
Lucas	97,147	105,536	8,739	9,326	11,233	+ 1,907
Mahaska	602,487	757,778	807,515	925,438	848,199	− 77,239
Marion	372,750	346,999	294,607	329,353	215,281	− 114,072
Monroe	2,458,473	2,476,021	1,967,337	2,025,559	2,184,030	+ 158,471
Page	11,235	14,338	11,364	16,134	10,550	− 5,584
Polk	1,369,506	1,460,203	1,616,895	1,788,129	1,778,264	− 9,865
Scott	24,778	1,047	1,248	8,400	400	− 8,000
Taylor	19,052	19,692	18,003	13,536	9,749	− 3,787
Van Buren	12,137	15,374	15,362	15,955	10,284	− 5,671
Wapello	243,256	258,651	189,506	261,520	283,500	+ 21,980
Warren	2,850	5,054	6,820	16,201	1,992	− 14,209
Wayne	136,694	146,901	127,409	128,004	135,439	+ 7,435
Webster	109,522	80,275	62,768	66,584	49,973	− 16,611
Other counties and small mines	25,100	23,907	25,309	24,283	34,410	+ 10,127
Total	7,266,224	7,574,322	7,161,310	7,757,762	7,928,120	+ 170,358
Total value	$11,619,455	$12,258,012	$11.706,402	$12,793,628	$13,903,913	+$1,110,285

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 1910, in short tons.

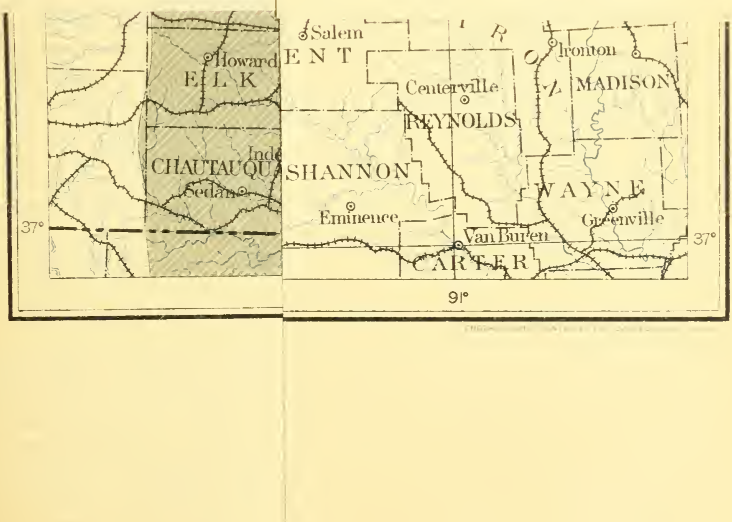
Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1840	400	1858	37,500	1876	1,250,000	1894	3,967,253
1841	500	1859	42,000	1877	1,300,000	1895	4,156,074
1842	750	1860	41,920	1878	1,350,000	1896	3,954,028
1843	1,000	1861	50,000	1879	1,400,000	1897	4,611,865
1844	2,500	1862	53,000	1880	1,461,116	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	1910	7,928,120
1857	33,000	1875	1,231,547	1893	3,972,229		
						Total.	164,455,984

As shown by this table, Iowa's total coal production to the close of 1910 has amounted to nearly 164,500,000 short tons, which, including the estimated loss of one-half ton for every ton recovered, represents an exhaustion of approximately 247,000,000 short tons. The original supply of coal in Iowa, as estimated by Mr. Campbell, was 29,160,000,000 short tons, from which it appears that there were still available at the close of 1910 something over 28,900,000,000 short tons, or a little over 99 per cent of the original supply. The quantity of coal still available is about 2,400 times the exhaustion caused by the output of 1910.

THE COAL FIELDS OF IOWA.

The coal-bearing formations of Iowa (Pl. V) occupy the central and southern portions of the State. They include an area of approximately 20,000 square miles, of which 13,000 may be considered potentially productive under present conditions and considerably more in future periods when the fuel supplies of the world shall have suffered greater depletion. The coal beds belong to the Pennsylvania series of the Carboniferous system. As in Missouri this series is readily separable on lithologic and economic grounds into an upper division known as the Missouri group, and a lower called the Des Moines group. The upper group is distinguished by the presence of numerous limestone strata and bears little coal of importance. The lower group consists mainly of shale and sandstone, containing little limestone, except in a thin formation near its middle part, and bears numerous beds of coal. The greater part of the coal output of the State comes from the lower part of the Des Moines group, where the coal beds and associated strata are extremely irregular, replacing one another within short distances both laterally and vertically. These coal beds are the thickest in the State, averaging about 5 feet, and produce a rather low-grade, noncoking bituminous coal that has fairly good steaming qualities, but carries considerable sulphur in the form of iron pyrites and does not stock so well as eastern fuels. The limestone-bearing formation of the Des Moines group includes one coal bed that is of considerable commercial importance and is known as the Mystic or Centerville bed. Both this bed and the strata associated with it are remarkably regular and persistent, retaining their essential character through about half of Appanoose and Wayne Counties in Iowa and a large area in Missouri. The coal bed is 30 inches thick and has a strong roof that is almost ideally adapted to the long-wall system of mining. The Missouri group contains only one coal bed of importance; this is the Nodaway bed in Page, Taylor, and Adams counties. It is only 16 to 20 inches in thickness, yet its regularity of occurrence, its fairly strong roof, and its distance from the larger mining centers render it of local value. Owing to the general southwesterly dip of about 10 feet per mile, the Missouri group in Iowa outcrops only in the southwestern part of the State.

The more important producing areas of Iowa are: (1) The northern, including Webster, Boone, and neighboring counties, and yielding 4 per cent of the total output; (2) The north central, including Polk, Jasper, and Dallas counties, and producing 29 per cent of the output, chiefly from Polk County; (3) The south central, including Marion, Mahaska, Monroe, and adjacent counties, and producing


Salem
ENT
Ironton
Howard
ELK
Centerville
MADISON
REYNOLDS
CHAUTAUQUA
SHANNON
Sedan
WAYNE
Eminence
Greenville
37°
Van Buren
37°
CARTER
91°

COAL FIELDS OF IOWA, KANSAS, AND MISSOURI

Scale $\frac{1}{2500000}$

25 0 25 50 75 100 Miles

1911

Areas known to contain workable bituminous coal

Areas that may contain workable coal

43 per cent of the total output; (4) The southeastern, including Wapello, Van Buren, and adjacent counties, and yielding 4 per cent of the total. In all of these areas practically all of the coal mined comes from the lower part of the Des Moines group. (5) The south central, including Appanoose and Wayne counties, and producing 19 per cent of the State's total. The coal mined is from the Mystic or Centerville bed. (6) The southwestern, including Adams, Taylor, and Page Counties, and yielding one-half of 1 per cent of the total. This product is from the Nodaway bed of the Missouri group.

The market for Iowa coal is largely confined within the borders of the State. Considerable coal is shipped to Nebraska, Minnesota, and other States, but an equal amount comes into Iowa from Illinois and eastern fields. Because of the growth of manufacturing industries within the State and the absence of much friction between miners and operators the coal-mining industry has enjoyed a steady increase in production and the outlook for future expansion is bright.

KANSAS.

Total production in 1910, 4,921,451 short tons. Spot value, $7,914,709.

What has been stated in regard to the influences of the coal miners' strike on the coal-mining industry of Arkansas, Oklahoma, and Missouri applies with even greater emphasis to Kansas, for in proportion to its production Kansas suffered greater loss in tonnage than did any of the other States. In 1909, when industrial peace reigned throughout the coal-mining States, Kansas produced 6,986,478 short tons, and in the boom year 1907 the output amounted to 7,322,449 tons, the maximum for the State. In 1910, when 80 per cent of the men were on strike, and the period of idleness exceeded that of activity, the production decreased to 4,921,451 short tons. Compared with 1909 this shows a loss of 2,065,027 short tons, or 29.56 per cent. The decrease in Arkansas amounted to 19.8 per cent, in Oklahoma to 15.17 per cent, and in Missouri to 20.6 per cent. As in the other States prices were naturally advanced by the shortage in fuel and the decrease in value was relatively less than the decrease in quantity. The value of the Kansas product decreased from $10,083,384 in 1909 to $7,914,709 in 1910, a loss of $2,168,765, or 21.5 per cent. The average price per ton advanced from $1.44 to $1.61.

The number of men employed in the coal mines of Kansas in 1910 was 12,870, of whom 10,346 were idle during the strike. The average number of days worked was 148, and the average number of days idle was 153. The total working time was 1,906,151 days, and the total idle time was 1,578,027 days. The average production per man was 382 tons annually, and 2.58 tons for each working day. In 1908, when 13,916 men were employed for an average of 181 days in the production of 6,245,508 tons, the average output per man was 449 tons for the year and 2.48 tons for each working day.

Sixty-five per cent of the decrease in 1910 was in the production of Crawford County, whose output decreased 1,341,601 short tons, and 35 per cent was in the production of Cherokee County, whose output in 1910 was 724,422 tons less than in 1909. Leavenworth County's production decreased 45,755 tons but this was offset by increases in Linn, Osage, and other less important counties amounting in the aggregate to 47,911 short tons. These increases were in counties where the production is from comparatively small mines with more or less local markets that were not affected, except beneficially, by the strike in the shipping districts.

Probably three-fourths of the production of Leavenworth County (275,377 short tons in 1910) 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 tonnage comes from the portion of the coal bed that underlies that State. It has been customary, however, to credit the production to the State in which the openings and tipples are located, and all the production from these mines is 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 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.

There were only 13 machines in operation in the coal mines of Kansas in 1910, a decrease from 16 in 1909. The machine-mined production decreased from 59,976 short tons in 1909 to 34,240 tons in 1910. The quantity mined by machines was 0.7 of 1 per cent of the total production. As most of the miners in Kansas are organized, the 8-hour working day prevails.

The statistics of the production of coal in Kansas in 1909 and 1910, with the distribution of the product for consumption, are shown in the following table:

Coal production of Kansas in 1909 and 1910, by counties, in short tons.

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 [a]	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

1910.

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	1,407,690	33,936	35,899		1,477,525	$2,232,818	$1.51	132	3,606
Crawford	2,858,040	63,311	65,060		2,986,411	4,578,266	1.53	148	7,458
Leavenworth	184,847	48,382	41,557	591	275,377	648,127	2.35	185	1,066
Linn	17,225	6,103	970		24,298	46,902	1.93	146	66
Osage	104,929	11,669	171		116,769	322,924	2.77	175	669
Other counties [b] and small mines	2,000	39,071			41,071	85,672			5
Total	4,574,731	202,472	143,657	591	4,921,451	7,914,709	1.61	148	12,870

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

The statistics of production, by counties, during the last five years, with increase and decrease in 1910 as compared with 1909, are shown in the following table:

Coal production of Kansas, 1906-1910, in short tons.

County.	1906	1907	1908	1909	1910	Increase (+) or decrease (−), 1910.
Atchison	(a)			(a)		
Cherokee	2,015,107	2,325,744	1,826,081	2,201,947	1,477,525	− 724,422
Cloud	3,000	6,512	4,500	800	800	
Crawford	3,415,068	4,380,628	3,917,818	4,328,012	2,986,411	− 1,341,601
Franklin	2,300	3,560	1,604	3,160	2,000	− 1,160
Leavenworth	377,846	424,338	348,117	321,132	275,377	− 45,755
Linn	32,652	27,488	11,581	8,544	24,298	+ 15,754
Osage	137,746	138,049	126,448	100,197	116,769	+ 16,572
Other counties and small mines	41,056	16,130	9,359	22,686	38,271	+ 15,585
Total	6,024,775	7,322,449	6,245,508	6,986,478	4,921,451	− 2,065,027
Total value	$8,979,553	$11,159,698	$9,292,222	$10,083,384	$7,914,709	−$2,168,675

[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 1860 to the close of 1910:

Production of coal in Kansas, 1869 to 1910, 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	1910	4,921,451
1878	375,000	1889	2,221,043	1900	4,467,870		
1879	460,000	1890	2,259,922	1901	4,900,528	Total	109,329,641

THE COAL FIELDS OF KANSAS.[1]

The coal measures of Kansas occupy the eastern portion of that State and underlie approximately 20,000 square miles, of which 15,000 have been estimated as probably more or less productive. The coal measures belong to the Pennsylvanian series of the Carboniferous and include the southwestern extension of the Iowa-Missouri field. The deposits differ somewhat from those of the adjacent States in that the division between the upper and lower portion is not so well marked. The limestones, which in Iowa and Missouri characterize especially the upper portion of the coal measures, are more prominent in Kansas, and coal is also found to some extent in

[1] See map (Pl. V) of Iowa, Kansas, and Missouri accompanying description of Iowa coal fields.

the upper beds as well as in the lower. The total thickness of the coal measures has been estimated at 3,000 feet. The dip is to the north and west, and the beds increase in thickness in that direction. The most important coal field in the State is that of Cherokee and Crawford counties, in the southeastern corner. In this field the Cherokee bed, which varies in thickness from 3 to 10 feet and has a general average of 40 to 42 inches, is largely mined. The coal is of better grade than that found in the adjacent States, and the mining conditions as regards roof and floor are excellent. Approximately 91 per cent of the output of the State comes from these counties. Some of the coal mined in this district possesses coking qualities, and a small quantity of coke is made from slack coal produced at the mines in the vicinity of Pittsburgh. About half of the coal used in coke making is washed before being charged into the ovens. The coke is used by the zinc smelters in and about Pittsburgh.

Some of the coal beds lie very near the surface, and mining operations are carried on by removing the overburden and stripping the coal. Some of this strip-pit coal is used raw in the smelting of zinc, for which purposes its absolute noncoking qualities make it especially adaptable. This fuel is known locally as "dead coal."

The second district of importance is that adjacent to Leavenworth and Atchison, in the northeastern portion of the State, where, at a depth of from 700 to 1,150 feet and at horizons equivalent to those mined in eastern Missouri, a thin bed of coal is found. This field yields a trifle less than 6 per cent of the total output of the State and is notable as being the only point at which deep mining is carried on in the Western Interior coal field. The third important district in Kansas is that of Osage and adjacent counties, in which a coal bed 20 to 22 inches thick is mined and yields approximately 3 per cent of the State's output. This bed is notable as being well up in the upper coal measures and stratigraphically 2,000 feet above the Cherokee coal. It occupies approximately the horizon of the bed locally mined in southwestern Iowa.

According to the estimates of M. R. Campbell, the total area of Kansas known to contain workable coal beds is 3,100 square miles, while the area of which little is known, but which may contain workable coal, is estimated at 15,780 square miles. The original coal supply is estimated to have been 7,022,000,000 short tons, from which there had been mined, to the close of 1910, 109,329,641 short tons. This represents an exhaustion, including the loss in mining, of about 164,000,000 short tons. Thus it would appear that about 2.2 per cent of the supply has been exhausted. The supply at the close of 1910 was equal to 763 times the average exhaustion of the last five years.

KENTUCKY.

Total production in 1910, 14,623,319 short tons; spot value, $14,405,887.

The stoppage of work in the coal mines affected by the strike of 1910 was of material benefit to the operators and miners in Kentucky, particularly in the western field. During the six months of idleness in the other States the shipments over the Louisville & Nashville Railroad from the western Kentucky coal field increased nearly 70 per cent over the corresponding period in 1909. The total production of the State increased from 10,697,384 short tons, valued at $10,079,917 in 1909, to 14,623,319 tons, valued at $14,405,887 in 1910, indicating a gain of 3,925,935 short tons, or 36.7 per cent, in quantity and of $4,325,970, or 42.92 per cent, in value. In the preliminary review of the coal trade in 1910, published as a press bulletin on January 3, 1911, it was stated that the increase in Kentucky's production was between 30 and 40 per cent. Of this increase the field in the western part of the State, which is contiguous to the strike-affected region, contributed 2,473,010 short tons, or 63 per cent, while the more remote areas in the eastern part of the State gained 1,452,925 short tons, or 37 per cent.

Notwithstanding the extraordinary demand upon the Kentucky mines, the labor supply was entirely adequate, as many of the miners who were thrown out of work by the strike in Illinois and the Southwestern States sought employment in Kentucky and in other States not affected by the strike order. By thus making up the deficiency caused by the idleness in the competitive States the miners aided materially in securing their demands.

The car supply in Kentucky during the strike period was sufficient for all requirements, but after the miners in the striking States resumed operations the railroad equipment was largely diverted from the Kentucky fields and production was cut down in consequence.

During 1910 the coal mines of Kentucky gave employment to 20,316 men, who worked an average of 221 days, showing an average production for each man employed of 720 tons for the year, and of 3.26 tons for each working day. In 1908 when the production amounted to 9,653,647 short tons, the average yearly and daily production by each man employed was 603 tons and 3.24 tons, respectively. Labor disaffections in the Kentucky mines were limited to short-lived strikes in 14 mines. The total number of men affected was 1,475, and the average time lost was 10 days.

Kentucky is one of the leading States in the mining of coal by the use of machines, and ranks next to Ohio in the percentage of machine-mined tonnage to the total production. In 1910 out of a total of 14,623,319 short tons, 9,362,851 tons, or 64 per cent, were machine-mined, against 6,461,593 tons, or 60.5 per cent of the total, in 1909. The quantity of coal mined by machines in 1910 was equal to nearly 90 per cent of the total production of the State in 1909. In 1910 there were 899 machines in use as compared with 877 in 1909. Of the 899 machines in 1910, 536 were punchers, 325 were chain-breast, 37 were long-wall, and 1 was of the "short-wall" or "continuous-cutter" type.

Of the 20,316 men employed in the coal mines of Kentucky, in 1910, 9,064 worked 10 hours, 3,965 worked 9 hours, and 6,095 worked 8 hours per day. The working time of 1,192 men was not reported.

From a statement made to the United States Bureau of Mines by Prof. C. J. Norwood, State geologist and chief mine inspector, there were 84 men killed and 120 injured in the coal mines of Kentucky in 1910, against 34 fatal and 98 nonfatal accidents in 1909. The death rate per thousand in 1910 was 4.13 and there were 174,087 tons of coal mined for each life lost. In 1909 there were 314,629 tons mined for each life lost, and the death rate per thousand was 2.01.

The statistics of production in 1909 and 1910, with the distribution of the product for consumption, are shown in the following table:

Coal production of Kentucky in 1909 and 1910, by counties, in short tons.

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 [a]	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

1910.

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	2,000,940	19,618	29,929	619	2,051,106	$2,206,636	$1.08	215	3,197
Boyd	95,071	4,650	3,330		103,051	86,921	.84	219	211
Carter	61,932	5,162	306		67,400	60,203	.89	188	116
Christian	33,388	1,364	2,384		37,136	41,007	1.10	204	99
Daviess	5,940	66,781	1,065		73,786	77,726	1.05	230	106
Floyd	134,565	895	1,870		137,330	127,628	.93	211	213
Henderson	172,932	61,532	6,817		241,281	239,332	.99	226	342
Hopkins	2,302,187	69,301	94,972	88,160	2,554,620	2,202,299	.86	256	2,595
Johnson	446,331	12,917	9,361		468,609	572,017	1.22	228	960
Knox	630,134	9,048	15,296		654,478	672,499	1.03	213	1,042
Laurel	253,955	12,840	8,429		275,224	288,515	1.05	163	713
Lawrence	97,677	1,389	1,829		100,895	89,258	.88	212	243
Lee	66,276	982	435		67,693	93,424	1.38	180	157
McLean	194,795	9,114	2,092		206,001	188,488	.91	230	255
Morgan	64,880	5,062	119		70,061	165,330	2.36	234	174
Muhlenberg	2,670,178	24,353	43,896		2,738,427	2,503,371	.91	212	3,360
Ohio	775,811	18,849	24,737		819,397	746,611	.91	210	1,290
Pike	934,219	5,937	12,725	724	953,605	869,501	.91	227	1,094
Pulaski	79,855	3,213	2,150		85,218	103,443	1.21	197	219
Union	511,143	41,240	30,907	7,088	590,378	538,888	.91	229	661
Webster	968,057	35,562	22,569		1,026,188	902,584	.88	232	1,087
Whitley	1,135,542	15,882	16,513		1,167,937	1,443,512	1.24	222	2,096
Other counties [b]	29,202	15,187	1,000		45,389	63,353	1.40	190	86
Small mines		88,109			88,109	123,341	1.40		
Total	13,665,010	528,987	332,731	96,591	14,623,319	14,405,887	.99	221	20,316

[a] Breathitt, Butler, Hancock, and Wayne.
[b] Breathitt, Butler, Crittenden, Greenup, Hancock, Harlan, Leslie, Rockcastle, and Wayne.

In the following table is present a statement of production of coal in Kentucky, by counties, during the last five years, with increase and decrease in 1910 as compared with 1909:

Coal production of Kentucky, 1906–1910, by counties, in short tons.

County.	1906	1907	1908	1909	1910	Increase (+) or decrease (−), 1910
Bell	989,108	1,437,886	1,557,924	1,538,568	2,051,106	+ 512,538
Boyd	48,822	55,284	61,319	86,904	103,051	+ 16,147
Breathitt and Lee	119,168	87,941	181,551	105,091	92,125	− 12,966
Butler	15,735	10,271	6,858	7,228	1,756	− 5,472
Carter	158,748	120,627	83,546	81,404	67,400	− 14,004
Christian, Daviess, and Hancock	161,753	150,248	128,195	121,738	117,286	− 4,452
Greenup	719	902	1,474	....	290	+ 290
Henderson	201,007	217,582	196,023	163,782	241,281	+ 77,499
Hopkins	2,165,342	2,064,154	1,864,346	1,864,453	2,554,620	+ 690,167
Johnson	89,451	122,590	158,270	222,746	468,609	+ 245,863
Knox	549,726	706,491	515,210	610,705	654,478	+ 43,773
Laurel	402,373	319,281	207,084	214,251	275,224	+ 60,973
Lawrence	47,279	29,673	22,975	96,440	100,895	+ 4,455
McLean	168,425	150,205	105,469	128,015	206,001	+ 77,986
Muhlenberg	1,492,331	1,882,913	1,784,285	2,009,549	2,738,427	+ 728,878
Ohio	707,585	658,645	601,138	626,158	819,397	+ 193,239
Pulaski	181,720	135,225	99,505	61,723	85,218	+ 23,495
Rockcastle	13,358	6,500	....	....	5,000	+ 5,000
Union	416,013	507,855	499,729	444,457	590,378	+ 145,921
Webster	501,430	608,693	559,247	449,508	1,026,188	+ 576,680
Whitley	781,354	762,923	811,114	933,154	1,167,937	+ 234,783
Other counties and small mines	442,200	717,235	801,291	931,510	1,256,652	+ 325,142
Total	9,653,647	10,753,124	10,246,553	10,697,384	14,623,319	+ 3,925,935
Total value	$9,809,938	$11,405,038	$10,317,162	$10,079,917	$14,405,887	+$4,325,970

In the following table the statistics of Kentucky's coal production during the last five years are divided according to the counties in the eastern and the western districts. It is to be observed that although the mines in the western district contributed the larger share of the output, the eastern district made a considerable gain in 1909. This gain, which was due to the active developments in the Elkhorn and other promising fields in the eastern part of the State, was followed by another increase of nearly 1,500,000 tons in 1910, and would probably in that year have exceeded the production in the western fields except for the impetus given the western district by the strike in Illinois and other States.

Coal production of the eastern district of Kentucky, 1906–1910, in short tons.

County.	1906	1907	1908	1909	1910	Increase(+) or decrease (−), 1910.
Bell	989,108	1,437,886	1,557,924	1,538,568	2,051,106	+ 512,538
Boyd	48,822	55,284	61,319	86,904	103,051	+ 16,147
Breathitt	37,350	25,300	23,100	20,982	24,432	+ 3,450
Carter	158,748	120,627	83,546	81,404	67,400	− 14,004
Greenup	719	902	1,474	....	290	+ 290
Johnson	89,451	122,590	158,270	222,746	468,609	+ 245,863
Knox	549,726	706,491	515,210	610,705	654,478	+ 43,773
Laurel	402,373	319,281	207,084	214,251	275,224	+ 60,973
Lawrence	47,279	29,673	22,975	96,440	100,895	+ 4,455
Lee	81,818	62,641	158,451	84,109	67,693	− 16,416
Pulaski	181,720	135,225	99,505	61,723	85,218	+ 23,495
Rockcastle	13,358	6,500	....	....	5,000	+ 5,000
Whitley	781,354	762,923	811,114	933,154	1,167,937	+ 234,783
Other counties and small mines	386,825	672,404	746,461	875,113	1,207,691	+ 332,578
Total	3,768,651	4,457,727	4,446,433	4,826,099	6,279,024	+1,452,925

Coal production of the western district of Kentucky, 1906–1910, in short tons.

County.	1906	1907	1908	1909	1910	Increase(+) or decrease (−), 1910.
Butler	15,735	10,271	6,858	7,228	1,756	− 5,472
Christian	80,065	62,901	67,040	45,453	37,136	− 8,317
Daviess	52,643	73,907	51,155	61,175	73,786	+ 12,611
Hancock	29,045	13,440	10,000	15,110	6,364	− 8,746
Henderson	201,007	217,582	196,023	163,782	241,281	+ 77,499
Hopkins	2,165,342	2,064,154	1,864,346	1,864,453	2,554,620	+ 690,167
McLean	168,425	150,205	105,469	128,015	206,001	+ 77,986
Muhlenberg	1,492,331	1,882,913	1,784,285	2,009,549	2,738,427	+ 728,878
Ohio	707,585	658,645	601,138	626,158	819,397	+ 193,239
Union	416,013	507,855	499,729	444,457	590,378	+ 145,921
Webster	501,430	608,693	559,247	449,508	1,026,188	+ 576,680
Other counties and small mines	55,375	44,831	54,830	56,397	48,961	− 7,436
Total	5,884,996	6,295,397	5,800,120	5,871,285	8,344,295	+2,473,010

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 shown in the following table.

The estimates of Mr. Campbell place the original supply of coal in Kentucky at 104,028,000,000 short tons. The total production to the close of 1910 has amounted to approximately 158,000,000 tons, representing an exhaustion of 237,000,000 tons, or 0.23 per cent of the original supply.

Production of coal in Kentucky from 1828 to 1910, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1828	328	1850	150,000	1872	380,800	1894	3,111,192
1829	2,000	1851	160,000	1873	400,000	1895	3,357,770
1830	2,000	1852	175,000	1874	360,000	1896	3,333,478
1831	2,100	1853	180,000	1875	500,000	1897	3,602,097
1832	2,500	1854	190,000	1876	650,000	1898	3,887,908
1833	2,750	1855	200,000	1877	850,000	1899	4,607,255
1834	5,000	1856	215,000	1878	900,000	1900	5,328,964
1835	6,000	1857	240,000	1879	1,000,000	1901	5,469,986
1836	8,000	1858	250,000	1880	946,288	1902	6,766,984
1837	10,000	1859	275,000	1881	1,232,000	1903	7,538,032
1838	11,500	1860	285,760	1882	1,300,000	1904	7,576,482
1839	16,000	1861	280,000	1883	1,650,000	1905	8,432,523
1840	23,527	1862	275,000	1884	1,550,000	1906	9,653,647
1841	35,000	1863	250,000	1885	1,600,000	1907	10,753,124
1842	50,000	1864	250,000	1886	1,550,000	1908	10,246,553
1843	60,000	1865	200,000	1887	1,933,185	1909	10,697,384
1844	75,000	1866	180,000	1888	2,570,000	1910	14,623,319
1845	100,000	1867	175,000	1889	2,399,755		
1846	115,000	1868	160,000	1890	2,701,496	Total.	157,971,830
1847	120,000	1869	160,000	1891	2,916,069		
1848	125,000	1870	150,582	1892	3,025,313		
1849	140,000	1871	250,000	1893	3,007,179		

THE COAL FIELDS OF KENTUCKY.[1]

Kentucky is the only one of the coal-producing States which has within its borders areas belonging to any two of the great coal fields. The eastern counties of the State are underlain by the coal beds of the great Appalachian Mountain system, extending entirely across the State in a northeast-southwest direction, while the southern limits of the central or eastern interior field are found in the more northern counties of the western part of the State. The total area underlain by coal in the eastern counties of Kentucky is estimated at 10,270 square miles, and the coal-bearing areas in the western part of the State are estimated to contain 6,400 square miles, or somewhat more than one-half of that of the eastern part. Up to the close of 1910 the western district, however, produced considerably more than half the total output of the State, but the very extensive developments now in progress in Pike, Johnson, and other counties of the eastern portion of Kentucky, promise a production in the eastern district that will soon exceed that of the western.

From a practical standpoint, the eastern Kentucky coal field is a unit, unless the Middlesboro-Harlan field, cut off by the Pine Mountain fault, be excepted. The great bulk of the area of this field (10,270 square miles) has at present no transportation facilities, and development has been confined to the close proximity of the few lines of railroad that cross or enter the field. Thus, at the north there are about a dozen commercial mines on the Chesapeake & Ohio Railway, where it crosses Carter and Boyd counties. Lawrence, Johnson, Lee, and Breathitt counties each supports a few mines. The Chesapeake & Ohio has completed a line into the Elkhorn and Miller Creek fields, the latter of which is already reported to have an annual production of 1,000,000 tons. Several large mines are located in the southern portion of the field along the Cincinnati Southern Railway in Pulaski County and western Whitley County. Along the Louisville

[1] See maps (Pls. IV and XIV) of eastern Kentucky accompanying description of West Virginia coal fields and of western Kentucky accompanying description of Illinois fields.

& Nashville Railroad are a detached group of mines in Laurel County, and scattered mines in Knox, Bell, and Whitley counties.

The coals of this field belong to the Allegheny formation ("Lower Productive Coal Measures") and to the Pottsville group. The Pottsville, which at the Ohio River has a thickness of only a few hundred feet, and carries 5 coals, is in the southeastern corner of the State, about 5,000 feet thick, and carries nearly 50 coals, of which a dozen or more are locally of workable thickness and quality. The eastern Kentucky coals are mostly high-grade "gas" or "coking" coals, with some cannel coal. In the Jellico coal field the Jellico and the Blue Gem beds are both thin, the latter being successfully mined where averaging only 22 inches. On the other hand, some of the beds show 8 and 9 feet or more of workable coal.

The workable coal of the western district of Kentucky is confined, for the most part, to two beds, designated as No. 9 and No. 11 by the Geological Survey of Kentucky. Of these, No. 9 (equivalent to No. 5 of the Illinois field) is the more persistent and furnishes probably 75 per cent or more of the total production of the western counties of the State. It underlies the whole or portions of eight counties, including all of the field except its eastern portion and the southern or southwestern edge and a few other places, where it has been cut out by irregularities in the structure, which near the west and south borders of the field is seriously affected by faults. The bed has an average thickness of about 5 feet, and only rarely thickens out to more than 5 feet 6 inches or thins down to less than 4 feet 6 inches. Over a broad zone it lies within 300 feet below the surface, and the mining is done by shaft. Bed No. 11 lies from 40 to 100 feet above No. 9, and is the next important bed in western Kentucky. It is much more irregular than No. 9, but usually where worked has a thickness of 6 feet or over. Another bed lying about 25 feet above No. 11 is known as No. 12. It is mined in Webster, Hopkins, McLean, and Muhlenberg counties. In the central portion of this field this bed attains a thickness of from 3 to 6 feet. Other beds besides these three are mined at several localities in the district, notably what is supposed to be No. 6 and also No. 5.

MARYLAND.

Total production in 1910, 5,217,125 short tons; spot value, $5,835,058.

Maryland, like Virginia, benefited indirectly from the six months' strike among the miners in the central or Mississippi Valley States. Owing to the shortage of fuel in the Western States a large amount of West Virginia coal, particularly from the southern part of the State, was diverted from the seaboard to the temporarily more profitable markets in the West. Profiting by this, Virginia's production, shipped principally to Lambert Point piers near Norfolk, increased over 1,750,000 tons, or 37 per cent. Maryland's production, which, because of the approaching exhaustion of the famous "Big Vein," had been showing a declining tendency for the last two years, was also given an impetus by the trade conditions in 1910 and increased from 4,023,241 short tons in 1909 to 5,217,125 tons in 1910, a gain of 1,193,884 tons, or 29.67 per cent. The value increased $1,363,327, or 30.5 per cent, from $4,471,731 to $5,835,058.

There were 38 mining machines employed in the coal mines of Maryland in 1910, a decrease of 1 as compared with 1909, but the machine-mined production increased from 117,568 tons to 137,216 tons. The machines are used where the thinner beds are worked and as the production from the "Maryland Big Vein" grows proportionately less as it gradually becomes exhausted, and the tonnage from the thinner beds becomes relatively larger, the use of machines for mining will increase.

The coal mines of Maryland gave employment in 1910 to 5,809 men who worked the unusually high average of 270 days, and although 97 per cent of Maryland's tonnage is hand mined the average productive efficiency of the miners is considerably above the mean average for all the States. In 1910 the average production for each man employed was 898 short tons for the year and 3.33 for each working day. As statistics for 1909, as collected by the Census Office are not available, comparisons are made with 1908 and 1907. The average production per man in these two years were—1908, 720 tons for the year and 3.27 tons for each day; 1907, 941 tons for the year and 3.58 tons per day. There were no labor troubles reported in the coal mines of Maryland in 1910. The mines in Maryland are operated 10 hours a day.

The statistics of production during the last five years, with the distribution of the product for consumption, which for 1910 as for 1908 were collected through a cooperative agreement with the Maryland Geological Survey, are shown in the following table:

Distribution of the coal product of Maryland, 1906–1910, 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.
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
1910	5,097,347	62,760	57,018	5,217,125	5,835,058	1.12	270	5,809

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 & Ohio Railroad, in 1842 and of the Chesapeake & Ohio Canal, in 1850, the output from the Maryland mines increased rapidly.

The attempt to ship coal from the Maryland mines by barges, prior to the advent of the Baltimore & 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 & 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 Pennsylvania 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 shipment have been carefully preserved and are published annually in the reports of the Cumberland coal trade, and the table following, which shows the shipments from this entire region, has been obtained from these reports.

The estimated supply of coal contained in an area of 455 square miles was 8,044,000,000 tons, from which the total production to the close of 1910 amounted to 161,224,007 short tons, representing an exhaustion, including waste, of 242,000,000 tons, or about 3 per cent of the original estimated contents of the Maryland coal fields. Deducting the total exhaustion from the original supply, it is found that there still remain in the coal fields of Maryland, at the close of 1910, 7,802,000,000 tons, which is 1,400 times the production of 1910 and over 900 times the exhaustion represented by the output of last year.

The annual production from the coal mines of Maryland from 1842 to the close of 1910 has been as follows:

Production of coal in Maryland from 1820 to 1910, 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	1910	5,217,125
1854	812,727	1873	3,198,911	1892	3,419,962		
1855	735,137	1874	2,899,392	1893	3,716,041	Total	161,224,007
1856	817,659	1875	2,808,018	1894	3,501,428		
1857	654,017	1876	2,126,873	1895	3,915,585		

THE COAL FIELDS OF MARYLAND.[1]

The Maryland coals,[2] like all the coals of the Appalachian States, are of Carboniferous age. They occur in five basins, known as the Georges Creek Basin, the Upper Potomac Basin, the Castleman Basin, the Lower Youghiogheny Basin, and the Upper Youghiogheny Basin.

The present production of coal for the market is almost exclusively confined to the first two basins. The far greater prominence of the Georges Creek Basin has led to the application of the name "Georges Creek coal" to most of the coal shipped from the State. Until within recent years practically all of this coal came from the Pitts-

[1] See map (Pl. XIV) accompanying description of West Virginia coal fields.
[2] The coals of Maryland are described in detail in vol. 5 and other reports of the Maryland Geological Survey.

burgh seam or "Big Vein," but the gradual exhaustion of this wonderful seam has led to the exploitation with most satisfactory results of many of the "Small Veins" both above and below the chief seam. There are many companies to-day mining the smaller seams either exclusively or in conjunction with the large seam. There is unquestionably a great future for these smaller seams in Maryland, especially in the Upper Potomac Basin in southern Garrett County, where they reach their greatest thickness. The total amount of coal in these small seams exceeds manyfold that originally contained in the "Big Vein."

The following table shows the production of coal in Maryland, by individual beds and by counties:

Production of coal in Maryland, by beds and counties, in short tons.

Bed.	Allegany County.	Garrett County.	Total.
Upper Sewickley	227,511	....	227,511
Pittsburgh	2,814,364	137,906	2,952,270
Bakerstown	98,696	19,945	118,641
Upper Freeport	....	13,077	13,077
Lower Kittanning	212,998	386,712	599,710
Clarion	8,340	....	8,340
Total	3,361,909	557,640	3,919,549

The Maryland Geological Survey gives the following table showing the average composition of the coals from the different coal beds which are at present worked. The coals of the Georges Creek and the Potomac basins are semibituminous in character. Those of the other basins are for the most part bituminous.

Average composition of leading Maryland coals of the Georges Creek Basin.

Coal seam.	Moisture.	Volatile carbon.	Fixed carbon.	Ash.	Sulphur.	Calorimetric values in—	
						Calories.	British thermal units.
Upper Sewickley or "Tyson"	0.83	20.22	70.09	8.86	1.40	7,784	14,011
Pittsburgh or "Big Vein"	.70	18.78	73.13	7.12	1.02	7,920	14,256
Bakerstown	1.10	18.64	70.32	9.94	2.07	7,757	13,973
Upper Freeport	1.21	19.47	68.70	10.17	1.73	7,764	13,975
Lower Kittanning or "Six-foot"	1.26	19.52	67.20	12.01	2.13	7,484	13,471
Brookville or "Bluebaugh"	.91	21.04	68.83	9.22	1.30	7,729	13,912

The most important of the seams, after the Pittsburgh or "Big Vein," are the Upper Sewickley, the Bakerstown, the Upper Freeport, and the Middle and the Lower Kittanning, all of which are being successfully mined at the present time. Others, like the Franklin or "Dirty Nine," contain so little good coal as to be practically valueless.

MICHIGAN.

Total production in 1910, 1,534,967 short tons; spot value, $2,930,771.

Michigan's coal production has decreased in each of the last two years. The output in 1909 was 1,784,692 short tons, which was a little more than 50,000 tons, or about 3 per cent less than that of 1908. In 1910 the production amounted to 1,534,967 short tons, a decrease as compared with 1909 of 249,725 short tons, or 14 per cent. The value decreased from $3,199,351 to $2,930,771, a loss of $268,580, or 8.39 per cent. Although the decrease in value was less in proportion than the decrease in tonnage it appears that the reasons assigned for the decrease in 1909 are applicable to 1910; that is, a development for several years preceding 1909 of coal properties in excess of the ability of the market to absorb the product. The decrease in 1910 was also partly attributable to labor troubles, for of the 3,575 men employed, 1,663 were on strike. In Michigan the strike lasted from April 1 to June 1 and the average time lost for each man on strike was 52 days, but the time lost by the strike was only 11 per cent of the time worked, and the decrease in tonnage was 14 per cent.

The two counties of Bay and Saginaw produce over 90 per cent of Michigan's total output of coal and the tonnage is nearly equally divided between the two counties. In 1909 Saginaw County had the larger production, and in 1910 Bay County had the lead. Smaller quantities are produced in Clinton, Eaton, Genesee, Ingham, Jackson, Shiawassee, and Tuscola Counties, the aggregate production from these counties in 1910 being 101,215 tons. The salt industry of Michigan furnishes the principal market for the coal.

The 3,575 men employed in the coal mines of Michigan worked in 1910 an average of 211 days. The average production for each man employed was 429 short tons for the year and 2.03 tons for each working day, each average being much below those of most of the States. There were 100 mining machines reported in 1910, a decrease of 1 from 1909. The machine-mined production, however, increased from 511,895 short tons in 1909 to 698,191 tons in 1910. Practically all the mines in the State work 8 hours a day.

There are 8 establishments in Michigan that have installed coal-washing machinery. In 1910, 186,128 tons of the product were washed, yielding 159,971 tons of cleaned coal and 26,157 tons of refuse.

The statistics of the production of coal in Michigan, by counties, during 1909 and 1910, with the distribution of the production for consumption, are shown in the following table:

Coal production of Michigan in 1909 and 1910, by counties, in short tons.

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[a] 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] Clinton, Eaton, Ingham, Jackson, Shiawassee, and Tuscola.

Coal production of Michigan in 1909 and 1910, by counties, in short tons—Continued.

1910

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam add heat.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average cumber of employees.
Bay	699,544	36,637	30,289	766,470	$1,432,293	$1.87	220	1,554
Saginaw	583,399	57,507	26,376	667,282	1,290,933	1.93	206	1,740
Other counties[a] and small mines	72,876	16,329	12,010	101,215	207,545	2.05	188	281
Total	1,355,819	110,473	68,675	1,534,967	2,930,771	1.91	211	3,575

[a] Clinton, Eaton, Genesee, Ingham, Shiawassee, and Tuscola.

The statistics of production, by counties, during the last five years, with increase and decrease in 1910 as compared with 1909, are shown in the following table:

Coal production of Michigan, 1906–1910, by counties, in short tons.

County.	1906	1907	1908	1909	1910	Increase (+) or decrease (−), 1910.
Bay	481,398	962,574	782,503	822,577	766,470	− 56,107
Eaton	18,507	5,982	2,286	558	100	− 458
Jackson	8,658	5,645	5,539	1,500	....	− 1,500
Saginaw	835,475	1,047,927	999,338	859,434	667,282	− 192,152
Shiawassee	[a] 2,300	13,730	[b] 45,353	[c] 100,623	[d] 101,115	+ 492
Total	1,346,338	2,035,858	1,835,019	1,784,692	1,534,967	− 249,725
Total value	$2,427,404	$3,660,833	$3,322,904	$3,199,351	$2,930,771	−$268,580

[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.
[d] Includes Clinton, Genesee, Ingham, and Tuscola Counties and small mines.

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 been tardy, however, 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 1910 is shown in the following table:

Production of coal in Michigan, 1860 to 1910, 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	1910	1,534,967
1872	33,600	1885	45,178	1898	315,722		
						Total	18,997,621

THE COAL FIELDS OF MICHIGAN.

The coal fields of Michigan (Pl. VI) are confined entirely to the lower peninsula. An area of approximately 11,000 square miles is included within the coal-bearing formations which lie almost in the exact center of the lower peninsula. This is the only known coal field within the drainage area of the Great Lakes. The developments have been principally in the eastern portion of the field and in a line running from Bay City, on the north, to Jackson, at the southern extremity of the field. The more important mining operations have been carried on in Bay and Saginaw counties, although some coal also has been mined in Shiawassee County, near Corunna, and in Eaton, Clinton, and Jackson counties.

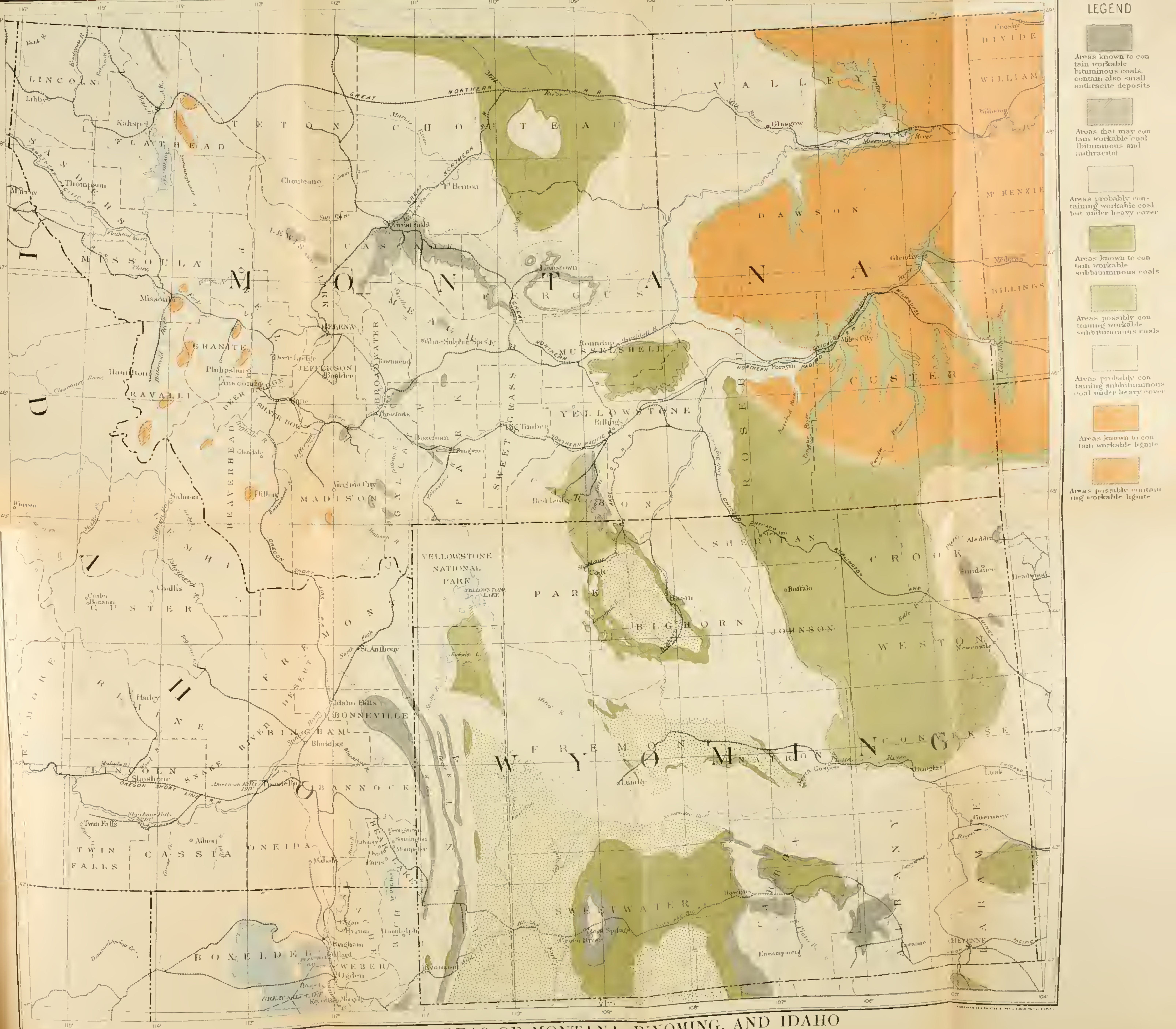
The coals of Michigan are, as a usual thing, of a lower grade than those coming from Ohio and Pennsylvania, with which they have to compete, but the rapid development and increase of population in the cities along Lake Michigan and Lake Huron and the Detroit and St. Clair rivers have created local markets for these coals, and the increase in production in this field during the last 10 years has been unrivaled in the coal-mining industry of the United States.

The coal basin lies for the most part in a low, flat country, surrounded by a rim of higher land which rises from 1,000 to 1,500 feet above the sea level, or from 500 to 1,000 feet above the lake.

According to Prof. Alfred C. Lane, there are seven horizons where the coal occurs in workable thickness, although it was formerly supposed that there was only one workable bed in the State. Owing to the varying character of the formation and the manner in which the coal beds run together and separate, no hard-and-fast classification is made, but the following, which has been adopted by Prof. Lane, is generally accepted as designating fairly the different beds, namely: Upper Rider, Upper Verne, Lower Verne, Middle Rider, Saginaw, Lower Rider, and Lower Coal. For more detailed description of these beds the reader is referred to the Twenty-second Annual Report of the United States Geological Survey, Part III.

All of the coals produced in Michigan are of the dry, noncoking, bituminous variety. Such coke as is manufactured in the State is from coal brought from Ohio or Pennsylvania.

Although coal mining in Michigan began about 70 years ago, it was not until within the last 11 years that it assumed any importance as



COAL AND LIGNITE AREAS OF MONTANA, WYOMING, AND IDAHO

Scale

an industry. Prior to 1896 there were only 4 years in which the production amounted to as much as 100,000 tons. During the last decade the rapid growth of population and manufacturing industries of the cities along the shores of Lake Huron has created a market for Michigan coals, and the production has increased rapidly, except for a setback in 1902 due to strikes among the mine workers and another in 1906 by the suspension previously referred to.

Michigan's original supply of coal, according to the estimate of Mr. Campbell, was 12,000,000,000 tons, contained in an area of 11,000 square miles of coal-productive territory. The production of the State at the close of 1910 amounted to 18,997,621 short tons, which, including the waste involved in the mining operations, represented an exhaustion of 28,500,000 short tons, or 0.24 of 1 per cent of the total original supply.

MISSOURI.

Total production in 1910, 2,982,433 short tons; spot value, $5,328,285.

Missouri's coal production in 1910, like that of the other States of the Mississippi Valley (Iowa and western Kentucky excepted), was materially reduced by the strike which began on April 1 and was not officially "called off" until September 15. Counting the additional time required for putting the mines in shape for operation after the order to resume work was issued, fully six months' producing time was lost. The actual time lost and the decrease in production was not, however, 50 per cent of the normal output or working time, for the strike order had been anticipated, and for the first three months of the year the mines were operated to the fullest possible extent in order to secure a supply of fuel, and when mining was resumed every effort was made by operators and miners to make up for lost time. In Missouri the production decreased from 3,756,530 short tons in 1909 to 2,982,433 short tons in 1910, the loss in output being 774,097 short tons, or 20.61 per cent. The scarcity of coal due to the strike naturally enhanced prices, and the value of the product in 1910 was $855,431, or 13.83 per cent, less than that of 1909, the figures being, respectively, $5,328,285 and $6,183,626.

Not all of the mines in Missouri were affected by the strike, nor did all of the affected mines continue idle for the entire time. The total number of men employed in the coal mines of Missouri in 1910 was 9,691. The number of men on strike was 7,774, and the periods of idleness ranged from 25 to 210 days, with an average for the 7,774 men of 157 days. The average number of days worked by the 9,691 men employed was 154. The time lost by the strike, therefore, was equivalent to 81.5 per cent of the time made, and yet the production in 1910 was nearly 80 per cent of that of the preceding year.

Even if the coal-mining industry were free from the biennial wage troubles, 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. The interruptions to their regular supplies of fuel caused by the biyearly conflicts between coal operators and their miners has created a tendency on the part of manufacturers to substitute oil and gas for coal.

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.

Mining machines in Missouri are chiefly used in the thin beds where long-wall mining is practiced and the long-wall type of machine is principally employed. In 1910 as in 1909 there were 96 machines in use, of which 73 were long-wall and 23 were punchers. The quantity of coal mined by machines in 1910 was 553,656 short tons against 796,438 tons in 1909.

The statistics of coal production in Missouri in 1909 and 1910, by counties, with the distribution of the product for consumption, are shown in the following table:

Coal production of Missouri, in 1909 and 1910, by counties, in short tons.

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[a]	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, Cass, Clay, Cole, Dade, Grundy, Harrison, Howard, Johnson, Livingston, Moniteau, Monroe, Montgomery, Morgan, Schuyler, Sullivan, and Vernon.

Coal production of Missouri, in 1909 and 1910, by counties, in short tons—Continued.

1910.

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	380,892	23,343	3,772	408,007	$675,979	$1.66	126	1,349
Audrain	21,189	17,252	2,221	40,662	85,014	2.09	237	155
Barton	216,095	2,896	3,604	222,595	350,501	1.57	188	502
Bates	80,238	14,453	760	95,451	168,802	1.77	145	273
Boone	2,437	17,354	94	19,885	41,001	2.06	219	62
Callaway	....	28,844	110	28,954	65,730	2.27	211	97
Henry	126,133	15,996	3,515	145,644	252,958	1.74	153	441
Lafayette	493,457	45,190	15,185	553,832	1,100,635	1.99	167	2,087
Linn	67,336	20,285	1,690	89,311	197,874	2.22	150	396
Macon	583,734	20,511	9,704	613,949	911,625	1.48	145	1,694
Putnam	56,996	5,292	680	61,968	123,424	1.99	184	213
Ralls	11,818	943	....	12,761	24,118	1.89	205	57
Randolph	163,744	25,043	4,695	193,482	314,864	1.63	132	707
Ray	265,374	21,208	5,860	292,442	590,000	2.02	159	1,217
Other counties[a]	44,049	41,454	4,481	89,984	197,555	2.20	141	441
Small mines	....	113,506	....	113,506	228,205	2.01	....	....
Total	2,512,492	413,570	56,371	2,982,433	5,328,285	1.79	154	9,691

[a] Caldwell, Carroll, Cass, Clay, Cole, Dade, Grundy, Harrison, Howard, Johnson, Livingston, Moniteau, Montgomery, Saline, Schuyler, Sullivan, and Vernon.

The statistics of production during the last five years, by counties, with increase and decrease in 1910 as compared with 1909, are shown in the following table:

Coal production in Missouri, 1906–1910, by counties, in short tons.

County.	1906	1907	1908	1909	1910	Increase (+) or decrease (−), 1910.
Adair	442,035	585,491	600,352	576,485	408,007	− 168,478
Audrain	34,233	38,265	37,479	41,207	40,662	− 545
Barton	218,623	193,418	129,632	259,766	222,595	− 37,171
Bates	210,218	115,285	133,700	147,322	95,451	− 51,871
Boone	40,626	33,034	25,868	18,000	19,885	+ 1,885
Caldwell	14,000	15,000	10,600	7,815	7,300	− 515
Callaway	41,162	34,413	22,534	25,179	28,954	+ 3,775
Grundy	7,990	11,040	10,821	9,818	9,640	− 178
Henry	115,679	209,652	219,974	263,352	145,644	− 117,708
Johnson	2,383	10,543	13,571	8,128	2,532	− 5,596
Lafayette	679,679	717,588	595,678	715,223	553,832	− 161,391
Linn	95,326	117,403	103,104	134,260	89,311	− 44,949
Livingston	2,000	2,010	1,010	400	200	− 200
Macon	770,284	1,156,140	833,060	790,083	613,949	− 176,134
Montgomery and Morgan	....	....	2,783	2,420	[a] 1,500	− 920
Putnam	104,899	51,675	50,775	48,120	61,968	+ 13,848
Ralls	17,510	12,024	11,802	16,009	12,761	− 3,248
Randolph	371,386	72,500	66,391	186,573	193,482	+ 6,909
Ray	276,341	337,384	263,288	277,075	292,442	+ 15,367
Vernon	140,570	141,379	47,281	20,278	7,208	− 13,070
Other counties and small mines	173,064	143,692	137,612	209,017	175,110	− 33,907
Total	3,758,008	3,997,936	3,317,315	3,756,530	2,982,433	− 774,097
Total value	$6,118,733	$6,540,709	$5,444,907	$6,183,626	$5,328,285	−$855,341

[a] Montgomery County only.

A statement of the annual production of coal in Missouri from 1840 to the close of 1910 will be found in the following table:

Production of coal in Missouri from 1840 to 1910, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1840	9,972	1859	260,000	1878	1,008,000	1897	2,665,626
1841	12,000	1860	280,000	1879	1,008,000	1898	2,688,321
1842	15,000	1861	300,000	1880	844,304	1899	3,025,814
1843	25,000	1862	320,000	1881	1,960,000	1900	3,540,103
1844	35,000	1863	360,000	1882	2,240,000	1901	3,802,088
1845	50,000	1864	375,000	1883	2,520,000	1902	3,890,154
1846	68,000	1865	420,000	1884	2,800,000	1903	4,238,586
1847	80,000	1866	450,000	1885	3,080,000	1904	4,168,308
1848	85,000	1867	500,000	1886	1,800,000	1905	3,983,378
1849	90,000	1868	541,000	1887	3,209,916	1906	3,758,008
1850	100,000	1869	550,000	1888	3,909,967	1907	3,997,936
1851	125,000	1870	621,930	1889	2,557,823	1908	3,317,315
1852	140,000	1871	725,000	1890	2,735,221	1909	3,756,530
1853	160,000	1872	784,000	1891	2,674,606	1910	2,982,433
1854	175,000	1873	784,000	1892	2,733,949		
1855	185,000	1874	789,680	1893	2,897,442	Total	107,674,384
1856	200,000	1875	840,000	1894	2,245,039		
1857	220,000	1876	1,008,000	1895	2,372,393		
1858	240,000	1877	1,008,000	1896	2,331,542		

THE COAL FIELDS OF MISSOURI.[1]

The coal beds of Missouri belong to the Pennsylvanian series of the Carboniferous system and underlie the greater part of the territory north of Missouri River and of a triangular strip south of the river in the west-central part of the State. About 25,000 square miles contain coal-bearing formations, and of this area 15,000 square miles are potentially productive under present conditions, and more will yield supplies at some future period. On lithologic and economic grounds the Pennsylvanian series is readily separated into an upper division called the Missouri group and a lower known as the Des Moines group. The Missouri group contains an abundance of limestone and bears little coal of importance; the Des Moines group consists mainly of shale and sandstone, with a thin limestone-bearing member, about 150 feet below the top of the group. Except in the lower part of the Des Moines the coal beds and associated strata are remarkably persistent, retaining their distinguishing characters over broad areas.

Structurally the Pennsylvanian of Missouri is simple. In north-central Missouri it is essentially horizontal. Throughout the remainder of its extent it dips northwestward at the rate of 10 feet or less per mile, causing the bottom of the series to be over 1,600 feet below the surface in the northwest corner of the State. There is an overlap of the series toward the east, so that in northeastern Missouri the lower part of the Des Moines group is absent.

Missouri coal is a rather low-grade bituminous variety that does not stock well, but has fair steam-producing qualities. A small amount of coke has been made from it, which contains too much sulphur to be used in iron smelting. Practically all the coal mined comes from the Des Moines group and most of it from the limestone-bearing member and the strata 100 feet or less below it. Beyond the edge of the main Pennsylvanian outcrop are numerous isolated

[1] See map (Pl. V) accompanying the description of Iowa coal fields.

pockets of bituminous and cannel coal, one of which is as much as 80 feet thick. These outliers occupy depressions in the underlying limestone, and are of too limited extent to be of great economic importance, though their discovery has in many cases led to the loss of considerable capital in attempts at exploitation. The chief producing fields of the State are: (1) The Bevier, occupying parts of Macon, Randolph, Chariton, Howard, and Boone counties, and producing 27 per cent of the State's output from a bed that ranges from 3 to 6 feet in thickness. (2) The Lexington, including Lafayette, Ray, and Clay counties. The bed mined is only 14 to 26 inches thick and forms part of the limestone-bearing member of the Des Moines group. Because it is ideally adapted to the long-wall system of mining and is situated near large consuming centers, this bed, in spite of its thinness, produces 27 per cent of the total for the State. (3) The Southwestern, including various districts in Henry, Barton, Bates, and adjacent counties, where several beds are mined, chiefly in the lower part of the Des Moines group. About 20 per cent of the output comes from this part of the State. (4) The Novinger, in Adair County, which produces 15 per cent of the total output. The bed mined lies at the same stratigraphic horizon as the one in the Bevier field and averages 3½ feet in thickness. (5) The Marceline, in Linn County, where 4 per cent of the State's production is taken from a bed 29 inches thick. (6) The Mendota, in Putnam, Schuyler, and northwestern Adair counties. The coal of this field lies stratigraphically about 100 feet above that in the Novinger and probably at the same horizon as that of the Lexington field. It is the southern extension of the Mystic or Centerville bed of Iowa, but is not extensively mined in Missouri and produces only 2 per cent of the total for the State.

The original coal supply of Missouri, as estimated by M. R. Campbell, was 40,000,000,000 short tons, included within an area of 16,700 square miles. The production of the State, according to the best records available, amounted at the close of 1910 to nearly 107,674,384 tons, representing an exhaustion of approximately 161,000,000 tons, or 0.38 of 1 per cent of the estimated original supply.

MONTANA.

Total production in 1910, 2,920,970 short tons; spot value, $5,329,322.

In 1910, as in 1909, Montana exceeded all previous records in the production of coal. Compared with 1909, when the production amounted to 2,553,940 short tons, the output in 1910 showed an increase of 367,030 short tons, or 14.37 per cent. The value increased in less degree, the gain being $292,380, or 5.8 per cent, over $5,036,942. Montana was the only State in the Rocky Mountain region whose percentage of increase in value was less than the percentage of gain in output. There was a general falling off in prices all over the State, but it was particularly noticeable in Fergus and Yellowstone counties, where the recent developments of the Bull Mountain coal field have been carried on. This field was opened in 1908, and from practically nothing in that year (the small production of Fergus County in previous years being from the Judith Basin field in the northern part of the county) the output rose to nearly 400,000 tons in 1909 and to over 600,000 tons in 1910. The average price for coal in the two counties in 1909 was about $2.10 per short ton; in 1910 it was about $1.70. The production of Carbon County, where the coals of the Red Lodge field are worked, increased from 989,664 tons to 1,211,028 tons, and the average price per ton declined from $2.11 to $2.04. Cascade County, in which the Cottonwood-Belt districts are located, showed a decrease of 26,351 tons and a decline from $1.73 to $1.54 in the average price per ton. Park County's production also decreased, principally in the quantity of coal made into coke, but the average price advanced from $2.02 to $2.15. The announcement by the Chicago, Milwaukee & Puget Sound and the Great Northern railways of their intention to use oil as locomotive fuel from the Pacific coast to Missouri River may have been one of the influences that lowered the price of Montana coal in 1910. Being more remote from the markets naturally tributary to the Mississippi Valley coals, the production in Montana was not affected by the strikes in 1910 to the same extent as it was in Colorado, New Mexico, and Wyoming.

The coal mines of Montana gave employment in 1910 to 3,837 men, who worked an average of 239 days, indicating an output per man of 762 tons for the year and of 3.19 tons for each working day. In 1908, when 3,146 men were employed an average of 224 days in the winning of 1,920,190 tons of coal, the average production for each man was 610.4 tons for the year and 2.73 tons for each working day. Labor troubles did not materially affect the production of the State in 1910. The total number of men on strike during the year was 345, who were idle for an average of 111 days, the time lost being about 4 per cent of the time worked.

There were 99 mining machines in use in the coal mines of Montana in 1910, against 81 in 1909. The machine-mined tonnage did not, however, show a proportionate increase. In 1909 the 81 machines produced 840,686 short tons of coal, and in 1910 the 99 machines produced 866,401 tons.

The statistics of production, by counties, in 1909 and 1910, with the distribution of the product for consumption, are shown in the following table:

Coal production of Montana in 1909 and 1910, by counties, in short tons.

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

Coal production of Montana in 1909 and 1910, by counties, in short tons—Continued.

1910.

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	1,138,797	18,791	53,440	....	1,211,028	$2,470,205	$2.04	257	1,751
Cascade	854,615	40,431	33,260	....	928,306	1,425,820	1.54	223	1,098
Chouteau	5,472	11,180	675	....	17,327	46,286	2.67	153	72
Fergus	257,422	20,117	10,075	....	287,614	523,119	1.82	300	297
Park	53,911	3,623	3,381	37,519	98,434	211,655	2.15	170	350
Other counties [a]	346,870	3,974	23,920	....	374,764	644,889	1.72	227	269
Small mines	....	3,497	....	....	3,497	7,348	2.10	....	....
Total	2,657,087	101,613	124,751	37,519	2,920,970	5,329,322	1.82	239	3,837

[a] Broadwater, Gallatin, Missoula, Rosebud, Valley, 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 1910 as compared with 1909:

Production of coal in Montana, 1906–1910, by counties, in short tons.

County.	1906	1907	1908	1909	1910	Increase (+) or decrease (−), 1910.
Carbon	557,148	746,110	868,112	989,664	1,211,028	+ 221,364
Cascade	1,027,923	1,026,223	811,245	954,657	928,306	− 26,351
Chouteau	12,305	24,847	19,770	31,432	17,327	− 14,105
Fergus	29,182	45,760	90,318	221,663	287,614	+ 65,951
Gallatin	97,926	69,257	15,973	16,771	22,465	+ 5,694
Park	102,339	102,555	106,942	139,464	98,434	− 41,030
Other counties and small mines	3,098	2,105	7,830	200,289	355,796	+ 155,507
Total	1,829,921	2,016,857	1,920,190	2,553,940	2,920,970	+ 367,030
Total value	$3,240,357	$3,907,082	$3,771,248	$5,036,942	$5,329,322	+$292,380

According to the estimates of M. R. Campbell, the original coal supply of Montana was 303,060,000,000 short tons, from which there had been mined at the close of 1910, 32,134,233 tons, representing an exhaustion, including the waste in mining, of about 48,000,000 tons, or 0.016 per cent of the original supply. The coal-mining industry of Montana, according to the best records available, began in 1880, in which year, according to the United States census, the production amounted to 224 short tons. It was not until 1889 that the industry assumed any importance. The production increased nearly 800 per cent (from 41,467 short tons in 1888 to 363,301 short tons in 1889). During the next six years development advanced rapidly until in 1895 it exceeded 1,500,000 tons. From 1895 to 1905 the production remained practically steady, ranging from a minimum of 1,358,919 tons in 1904 to a maximum of 1,661,775 tons in 1900. It increased to 1,829,921 tons in 1906, and exceeded 2,000,000 tons for the first time in 1907. It decreased slightly in sympathy with the general falling off in 1908, but showed marked gains in 1909 and 1910, reaching nearly 3,000,000 tons in the latter year. The production in 1910 was over 1,000,000 tons larger than that of 1908.

The annual production from 1880 to 1910 is shown in the following table:

Production of coal in Montana from 1880 to 1910, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1880	224	1889	363,301	1898	1,479,803	1907	2,016,857
1881	5,000	1890	517,477	1899	1,496,451	1908	1,920,190
1882	10,000	1891	541,861	1900	1,661,775	1909	2,553,940
1883	19,795	1892	564,648	1901	1,396,081	1910	2,920,970
1884	80,376	1893	892,309	1902	1,560,823		
1885	86,440	1894	927,395	1903	1,488,810	Total	32,134,233
1886	49,846	1895	1,504,193	1904	1,358,919		
1887	10,202	1896	1,543,445	1905	1,643,832		
1888	41,467	1897	1,647,882	1906	1,829,921		

THE COAL FIELDS OF MONTANA.

The coal fields of Montana (Pl. VII) are widely scattered, embracing extensive areas in the plains and more limited basins in the mountain region.

The largest coal field lies in the eastern part of the State, including most of the counties of Rosebud, Custer, Dawson, and Valley. The coal of this field is low grade, consisting for the most part of lignite, but it also includes some low-grade subbituminous coal. The latter is mined in the vicinity of Miles City and Glendive to supply the local demand. The lignite occurs in the Fort Union formation and the subbituminous coal in the underlying Lance formation.

The field now attracting most attention and one that is destined to supply a large part of the coal mined in the State is located in the Bull Mountains, in Yellowstone County. This field lies chiefly south of Musselshell River, between Roundup and Musselshell post offices, and extends southward for a distance of about 25 miles. It is estimated to contain between 500 and 600 square miles. In the mountain region 14 distinct beds of coal have a thickness of 2 feet or more. Some of these measure from 3 to 5 feet, and one, the "Mammoth Seam," is from 8 to 15 feet thick.

The most important field from a commercial standpoint at the present time is in Carbon County, in the vicinity of Red Lodge and Bear Creek. This is generally known as the Red Lodge field. It contains 7 distinct beds of coal varying in thickness from 3 to 12 feet and covering an area estimated to be 32 square miles. Several extensive mines have been developed at Red Lodge and Bear Creek. At the present time about 1,000 miners are employed in the field. The coal of this field is subbituminous in character, but is so near the dividing line between subbituminous and bituminous that it is rather difficult to classify. It carries considerable moisture and upon exposure to the weather "slacks" or breaks down in a very short time. It is about the same quality as the coal of the Bull Mountain field, and both are classed as high-grade subbituminous coals.

The Bridger field in the valley of Clark Fork contains one bed of coal which has been mined near the town of Bridger for many years. The area of this field is probably not very extensive.

The Great Falls field, in Cascade County, is one of the most important in the State. Extensive mines are located at Sand Coulee, Stockett,

COAL AREAS OF ARIZONA AND NEW MEXICO

Scale $\frac{1}{2500000}$

25 0 25 50 75 100 Miles

and Belt, and, as shown in the foregoing table, 50 per cent of the total production of the State in 1907 was credited to this county. In 1910, however, owing to the increased production in Carbon, Fergus, and Yellowstone counties, Cascade County's proportion has decreased to 30 per cent. This field extends to the eastward nearly across Fergus County and southwestward for a number of miles up Hound Creek. The completion of the Billings & Northern Railroad through Judith Gap has afforded transportation facilities for the most of this field, but the coal, while bituminous, is generally dirty and not in great demand. The coal occurs in the Kootenai formation (Lower Cretaceous) and is the oldest coal in the State except that on the north fork of Flathead River.

Some coal is mined in the Milk River valley in the vicinity of Havre and Chinook, but the coal is low-grade subbituminous and the containing formations are so broken by faults that it seems probable that this field will never become an extensive producer.

High-grade coal is present in the Trail Creek and Electric fields. These fields are small, the coal beds badly disturbed, and the cost of mining is such that many of the mines have been abandoned.

The coal beds of Montana range in age from Lower Cretaceous to Fort Union (Eocene, lower Tertiary). Coal formed in Cretaceous time is of better quality than the later deposit, but the Tertiary beds are thicker and cover a much greater area. The coals are bituminous, subbituminous, and lignite, some of the first named producing a fair quality of coal. It is estimated that within this State 34,000 square miles are underlain by coal beds more than 2 feet in thickness.

NEW MEXICO.

Total production in 1910, 3,508,321 short tons; spot value, $4,877,151.

In the writer's preliminary review of the coal-mining industry in 1910, published as a press bulletin on January 3, 1911, it was stated that the coal production of New Mexico in 1910 exceeded that of 1909 by about 30 per cent. Complete returns show that the actual percentage of increase was 25.25. The production in 1910 amounted to 3,508,321 short tons against 2,801,128 tons in 1909, a gain of 707,193 short tons. The record for both years was the best attained. The value of the product increased from $3,619,744 to $4,877,151, a gain of $1,257,407, or nearly 35 per cent.

Mr. Jo E. Sheridan, Territorial mine inspector, in a letter to the writer attributes the increased production partly to the strike in the coal mines of the Middle States and the northern (Boulder) district of Colorado, and partly to the growth of population and the settlement of new lands in New Mexico, Arizona, and California, the latter creating a demand that will be permanent and growing. Both the bituminous and the subbituminous coals of New Mexico are rapidly growing in favor for domestic purposes, the former being shipped from the Raton field to markets in Kansas, Oklahoma, and even farther east, and the subbituminous coal of the Gallup district supplying the markets of the Southwest and the Pacific coast. The domestic demand for New Mexico coal in 1910 was so great that the operators were unable to fill orders promptly. The domestic trade requires lump coal, and an operator must have a corresponding demand for the smaller sizes for steam or manufacturing purposes to be able to fill the domestic orders. He can not afford to waste the smaller coal. The lack of demand for steaming coal probably restricted the production about 5 per cent. The production of 1910 would doubtless have been considerably larger if the operators had been able to obtain all the labor and railroad cars they desired.

One of the benefits accruing to the coal-mining industry of New Mexico in 1910 was the reduction in the freight rates on foreign coals by the Mexican railroads. When the Mexican Government took over the control of the railroads of that country it increased the freight rates on foreign coals in the hope of encouraging the development of the Mexican mines. As the railroads had considerable coal on hand they were able to furnish a sufficient supply of fuel during 1909, but with the depletion of the reserves it was found that the Mexican mines could not supply the demands of the railways and the other industries. In order to meet this deficiency with New Mexican coal, the Mexican Government reduced the freight on coal to the old rate and it is not probable than any further attempt will be made to exclude foreign coals from that Republic.

During 1910 great improvements were made in the methods of operating the mines. Each of the three larger operating companies has employed mine inspectors whose duty it is to look after the safety of the men employed. In addition to these mine inspectors the fire bosses and shot firers must also report any unsafe conditions in their respective districts, and when an accident occurs whereby any person is injured in the mine the circumstances and conditions are immediately investigated to discover if the workmen were allowed to go into an unsafe working place, and if so, the fire boss or shot firer who neglected to report such unsafe condition is held responsible.

The larger mines employ shot firers or explode the shots by electricity, and all shots are exploded after the miners and others (except the shot firers) have left the mine. Clay or other incombustible material is supplied at convenient places, to be used by the miner for tamping or stemming his shot holes. Traveling roads have been constructed for the employees to enter and leave some of the larger mines, in order that the dangers of the haulage roads may be avoided. Large and efficient fans furnish an abundance of air.

Colfax County, which contains the New Mexican portion of the Raton (New Mexico)-Trinidad (Colorado) field, is by far the most important coal-producing county of the Territory, contributing over 75 per cent of the total production and more than 90 per cent of the total increase in 1910. All of the other counties except Rio Arriba increased their output in 1910.

That the year 1910 was exceptional in the history of the coal-mining history of New Mexico is shown by the fact that the mines were in operation an average of 283 days, when 225 days is above the average in recent years. The average number of men employed during the year was 3,585, and the average production by each man was 979 tons for the year and 3.46 tons for each working day. The Territory was free from strikes in 1910.

Most of the coal mining in New Mexico is done by hand. In 1910 there were only three machines in use, and the machine-mined product was 71,609 tons, but a little more than 2 per cent of the total output. In 1909 the quantity of coal mined by machines was 1,352 tons.

The statistics of production, by counties, during 1909 and 1910, with the distribution of the product for consumption, are shown in the following table:

Coal production of New Mexico in 1909 and 1910, by counties, in short tons.

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.
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[a]	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

1910.

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.
Colfax	1,921,535	13,038	15,808	701,204	2,651,585	$3,310,412	$1.25	294	2,512
McKinley	673,481	5,727	19,522		698,730	1,161,951	1.66	252	766
Other counties[a]	125,625	13,677	10,718		150,020	391,156	2.61	275	307
Small mines		7,986			7,986	13,632	1.71		
Total	2,720,641	40,428	46,048	701,204	3,508,321	4,877,151	1.39	283	3,585

[a] 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 1910, as compared with 1909:

Coal production of New Mexico, 1906–1910, by counties, in short tons.

County.	1906	1907	1908	1909	1910	Increase (+) or decrease (−), 1910.
Colfax	1,292,241	1,844,550	1,781,635	2,013,318	2,651,585	+ 638,267
Lincoln		1,691	1,245	1,466	2,476	+ 1,010
McKinley	560,917	629,821	539,050	665,423	698,730	+ 33,307
Rio Arriba	43,600	34,450	20,000	12,266	10,200	− 2,066
Santa Fe	3,938	31,952	54,740	46,495	73,106	+ 26,611
Other counties and small mines	64,017	86,495	71,267	62,160	72,224	+ 10,064
Total	1,964,713	2,628,959	2,467,937	2,801,128	3,508,321	+ 707,193
Total value	$2,638,986	$3,832,128	$3,368,753	$3,619,744	$4,877,151	+$1,257,407

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 1907, indicating that in 26 years the coal production of New Mexico has increased more than 16 times. The annual production since 1882 is given in the following table showing the production of coal in the

State from the year of earliest recorded mining to the close of 1910. In this period the total production has amounted to 31,102,818 short tons, which, including mining and other loss, represents a total exhaustion of about 46,600,000 tons.

According to the estimate of M. R. Campbell, the original coal supply of the Territory of New Mexico (irrespective of fields whose boundaries are unknown) was 163,780,000,000 tons, so that the exhaustion to date represents approximately 0.03 of 1 per cent of the original supply. The production of 1910 was equal to nearly 12 per cent of the entire production to the close of that year, and the coal left in the ground is over 46,000 times the production in 1910, and over 30,000 times the exhaustion represented by that production.

Production of coal in New Mexico from 1882 to 1910, in short tons.

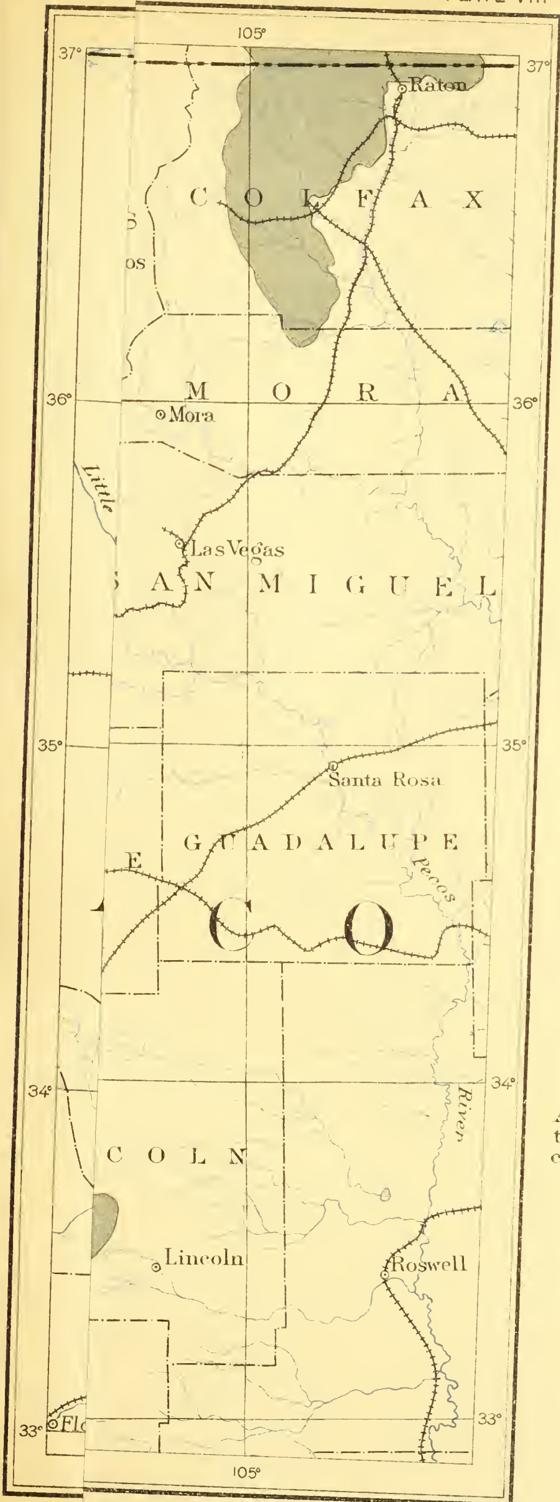
Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1882	157,092	1890	375,777	1898	992,288	1906	1,964,713
1883	211,347	1891	462,328	1899	1,050,714	1907	2,628,959
1884	220,557	1892	661,330	1900	1,299,299	1908	2,467,937
1885	306,202	1893	665,094	1901	1,086,546	1909	2,801,128
1886	271,285	1894	597,196	1902	1,048,763	1910	3,508,321
1887	508,034	1895	720,654	1903	1,541,781		
1888	626,665	1896	622,626	1904	1,452,325	Total	31,102,818
1889	486,943	1897	716,981	1905	1,649,933		

THE COAL FIELDS OF NEW MEXICO.

The coals of New Mexico (Pl. VIII), like most of those of the Rocky Mountain region, are of Cretaceous age, and vary in quality from subbituminous to anthracite. The latter occupies only limited areas in which the coal has been locally metamorphosed by volcanic intrusion. The production of anthracite from the Territory does not amount to 50,000 tons a year. The known coal-bearing areas of New Mexico are located in somewhat widely separated localities as follows: (1) The Raton field of Colfax County, which is the southern extension of the Trinidad field of Colorado; (2) the San Juan River region, which extends from Durango, Colo., southward through Rio Arriba, San Juan, and McKinley counties to Gallup and Mount Taylor, and which embraces the producing districts of Gallup and Monero; (3) a large area farther south and east than the one noted above, in Valencia, Bernalillo, and Sandoval counties, of which very little is known; (4) the Los Cerrillos field in Santa Fe County, including the little known areas east, south, and west of the Ortiz Mountains; and (5) the Whiteoaks field in Lincoln County.

The coal of the Raton field is a true coking coal, and a considerable quantity of coke is made each year. The majority of the coals of the Territory, however, belong to the subbituminous ("black lignite") class.

Several large mines have been opened in recent years in the Raton field, and the demand for coal of high fuel value and for coke such as is produced in this field is so great that the output is likely to increase rapidly. This change in production is foreshadowed by the large number of railway lines that have been surveyed into this field. In addition to the main line of the Atchison, Topeka & Santa Fe Railway, which crosses the field, the St. Louis, Rocky Mountain & Pacific



LEGEND

Areas known to contain workable bituminous coals; contain also small anthracite deposits

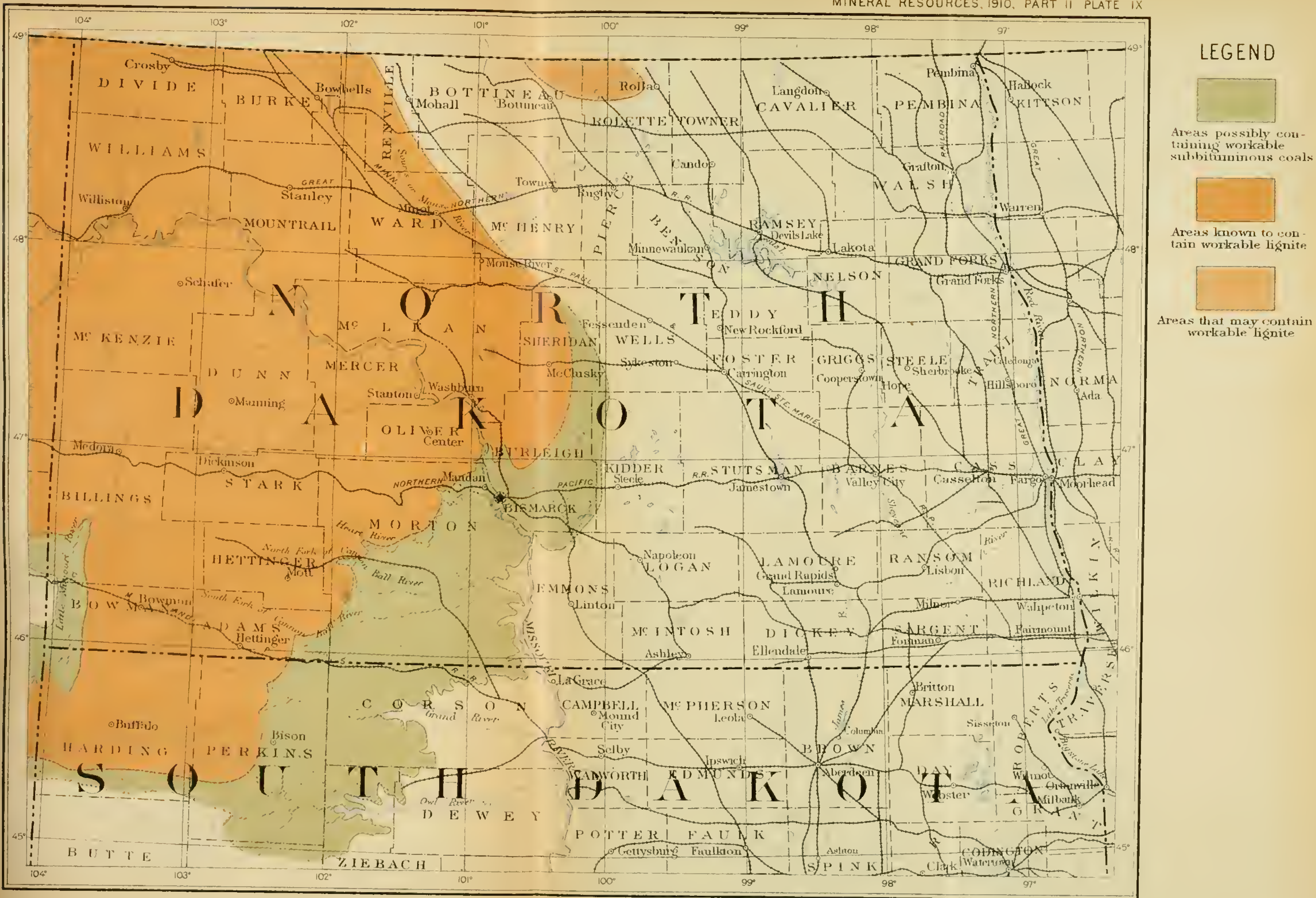
Areas that may contain workable coal (bituminous and anthracite)

Areas probably containing workable coal but under heavy cover

Areas known to contain workable subbituminous coals

Areas possibly containing workable subbituminous coals

Areas probably containing subbituminous coal under heavy cover



COAL AND LIGNITE AREAS OF NORTH DAKOTA AND SOUTH DAKOTA

Scale $\frac{1}{2500000}$

Railroad is in operation from Des Moines, on the Colorado & Southern Railway, through Raton to Ute Park, and the extension of this line has been surveyed westward toward the San Juan River region. Construction work has been done on two other lines, the Santa Fe, Raton & Des Moines Railroad and the Santa Fe, Raton & Eastern Railroad. The possible market for the products of the mines in this field is indicated by the increased demand for coke by the smelters of New Mexico and Arizona. Some of the coke now used in these smelters is shipped from distant points, such as Pennsylvania and West Virginia, and often from foreign countries by way of San Francisco. From this it is easily seen that the production of coke in the Southwest is far below the demand. The coal and coke of the Raton field compare favorably with those from eastern fields, and there is no obvious reason why they should not supply all of the needs of the smelters of the Southwest.

At the present time practically all of the mine products from the Raton field come from a few large mines working the lowest bed of coal. There are at least five coal beds known to be thick enough to be of great economic importance, although comparatively little development has been done on the higher beds. The second bed from the bottom, known as the Sugarite coal, has been opened east of Raton at the Sugarite mine, and the third bed has been developed to some extent at Yankee and is believed by some to be the same as the coal bed opened at Brilliant, which is located in Dillon Canyon northwest of Raton. No producing mines have been opened on the higher coal beds.

The San Juan River coal region is the largest in the Territory, containing about 13,000 square miles. About one-seventh of this area lies in Colorado and the remainder in New Mexico. The two centers of production in the New Mexico part are Monero in the north and Gallup in the south. At Monero the coal is bituminous, but it changes toward the south into high-grade subbituminous coal in the vicinity of Gallup.

The coal from the northern part of this field reaches the market over the Denver & Rio Grande system, and that from the south end of the field over the Atchison, Topeka & Santa Fe Railway. Recently this field has been attracting unusual attention, and the Denver & Rio Grande Railroad has built a standard-gage line southwest from Durango, Colo., to Farmington, N. Mex., on San Juan River, and there are persistent rumors that the Southern Pacific will build through this field northward to Denver.

The only other field in which active mining is carried on at the present time is located a few miles east of Socorro on the El Paso branch of the Atchison, Topeka & Santa Fe Railway. This field contains a coking coal, but the beds are so broken by faults and covered by recent material washed in from the higher land surrounding that mining is expensive and uncertain. The field has had a varied experience in its development, and for a long time was without railroad communication. Recently, however, a new road has been built connecting this field with the Santa Fe system, and it is probable that mining will be carried on in a systematic manner from now on.

NORTH CAROLINA.

The production of coal in North Carolina ceased in 1905. Coal mining in this State is now, therefore, only a matter of history. The earliest reported production is 3 tons recorded in the census of 1840. It is probable that from that date small mines yielded a few tons at infrequent intervals, although there is no evidence on this point prior to the Civil War. The Confederate Government is estimated to have obtained about 60,000 tons from the North Carolina mines between 1861 and 1865. After the war the production declined for several years, and from 1874 to 1879 none was reported from this State.

The Cumnock or Egypt mines in the Deep River field were reopened in 1889 and produced each year from that time until 1906. The output from the Cumnock mines amounted to 23,000 short tons in 1902, valued at $1.50 per ton, but it fell off to 17,309 tons in 1903, 7,000 tons in 1904, and 1,557 tons in 1905. Since that year the mines have been idle and no coal production has been reported. The abandonment of operations may be ascribed to a combination of circumstances, including steep dip of the coal beds, gaseous nature of the mines, expense of pumping water, the quality of the coal, and inability to compete with other coals except in a very small local market.

The coal in the Deep River field is in Triassic rocks and is of the same geologic age as the beds of the Richmond Basin in Virginia. The only other coal field in North Carolina is on Dan River in Stokes and Rockingham counties; this also is of Triassic age. The coal-bearing rocks extend from a point just north of the Virginia line southward through Leaksville, Madison, and Walnut Cove to Germanton, N. C. Black, slaty, carbonaceous shale is common, but coal occurs at only a few places. Nowhere has a deposit of coal of any commercial value been found. During the Civil War coal was mined near Leaksville and shipped by boat to Danville, Va. The coal is semianthracite, but the bed is so thin, so broken by shale partings, and of so small lateral extent that mining is unprofitable.

Considerable prospecting for coal has been done in the vicinity of Walnut Cove on beds tilted at angles from 20° to 60°. Semianthracite has been found, but it is nowhere more that 1 foot thick. There is, however, a bed of bright, black, soft, flaky coal or carbonaceous shale which ranges in thickness up to 10 feet. This flaky character was produced by squeezing, due to movement in the inclosing rocks, and the brightness is due to innumerable slickensided faces. This coal carries as high as 64 per cent ash and is very hard to burn. It has no present commercial value.

NORTH DAKOTA.

Total production in 1910, 399,041 short tons; spot value, $595,139.

One exception to the general increase in production among the States of the Rocky Mountain and the Great Plains provinces is noted in the output of North Dakota. All of the production from this State is lignite and does not enter into competition with the coals of other States, except in so far as the foreign coals are brought into North Dakota markets. Lignite does not bear long-distance transportation nor does it stand exposure for any length of time, and the output of North Dakota is restricted to relatively local markets. It is not a high-grade fuel and requires special furnaces with large grate areas when used for steam purposes, but it will serve for domestic use when other fuels are not available or are obtainable only at a high price. But although lignite is not a fuel of high calorific value, it has been found well adapted for certain purposes and is used satisfactorily for burning brick because of its smokeless and sootless qualities and relative low cost. It is used in considerable quantities for that purpose at Dickinson, Scranton, and Kenmare, and experience has shown that 1 ton of lignite is equal in efficiency to 1 cord of such wood as is available in the localities.

Lignite is also an excellent fuel for the generation of producer gas, and with the development of manufacturing industries in the State the extensive lignite deposits of North Dakota will receive more attention as a source of power. It has been found that 1 ton of lignite in the gas producer will yield as much horsepower in internal-combustion engines as will 1 ton of the best bituminous coal under boilers.

Compared with 1909, the production of lignite in North Dakota in 1910 showed a decrease of 23,006 short tons, or 5.45 per cent, in quantity, and of $50,003, or 7.75 per cent, in value. The number of men employed in 1910 was 534, who worked an average of 207 days. There were no strikes nor other labor troubles.

The statistics of production, by counties, in 1909 and 1910, with the distribution of the product for consumption, are shown in the following table:

Coal production of North Dakota in 1909 and 1910, by counties, in short tons.

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

1910.

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	126,250	9,644	6,703	142,597	$196,889	$1.38	220	177
McLean	1,500	2,490	100	4,090	5,101	1.25	223	6
Morton		23,225	25	23,250	24,609	1.06	243	14
Stark	49,500	5,700	1,500	56,700	80,110	1.41	255	64
Ward	87,829	27,917	1,636	117,382	204,149	1.74	180	231
Other counties [b]	3,958	22,813	663	27,434	40,701	1.48	210	42
Small mines		27,588		27,588	43,580	1.58		
Total	269,037	119,377	10,627	399,041	595,139	1.49	207	534

[a] Adams, Bowman, Emmons, Hettinger, and Mercer.
[b] Adams, Emmons, Hettinger, Oliver, and Williams.

The statistics of production, by counties, during the last five years, with increase and decrease in 1910, as compared with 1909, are shown in the following table:

Coal production of North Dakota, 1906–1910, by counties, in short tons.

County.	1906	1907	1908	1909	1910	Increase (+) or decrease (−), 1910.
Burleigh	83,267	123,662	116,957	122,422	142,597	+ 20,175
McLean	8,005	9,660	7,452	9,325	4,090	− 5,235
Morton	23,194	10,690	20,850	18,634	23,250	+ 4,616
Stark	63,785	71,563	38,467	72,550	56,700	− 15,850
Ward	120,962	124,214	115,780	139,996	117,382	− 22,614
Williams	4,431	5,400	13,969	18,722	17,380	− 1,342
Small mines	[a] 2,045	[a] 2,571	[b] 7,267	[c] 40,398	[d] 37,642	− 2,756
Total	305,689	347,760	320,742	422,047	399,041	− 23,006
Total value	$451,382	$560,199	$522,116	$645,142	$595,139	−$50,003

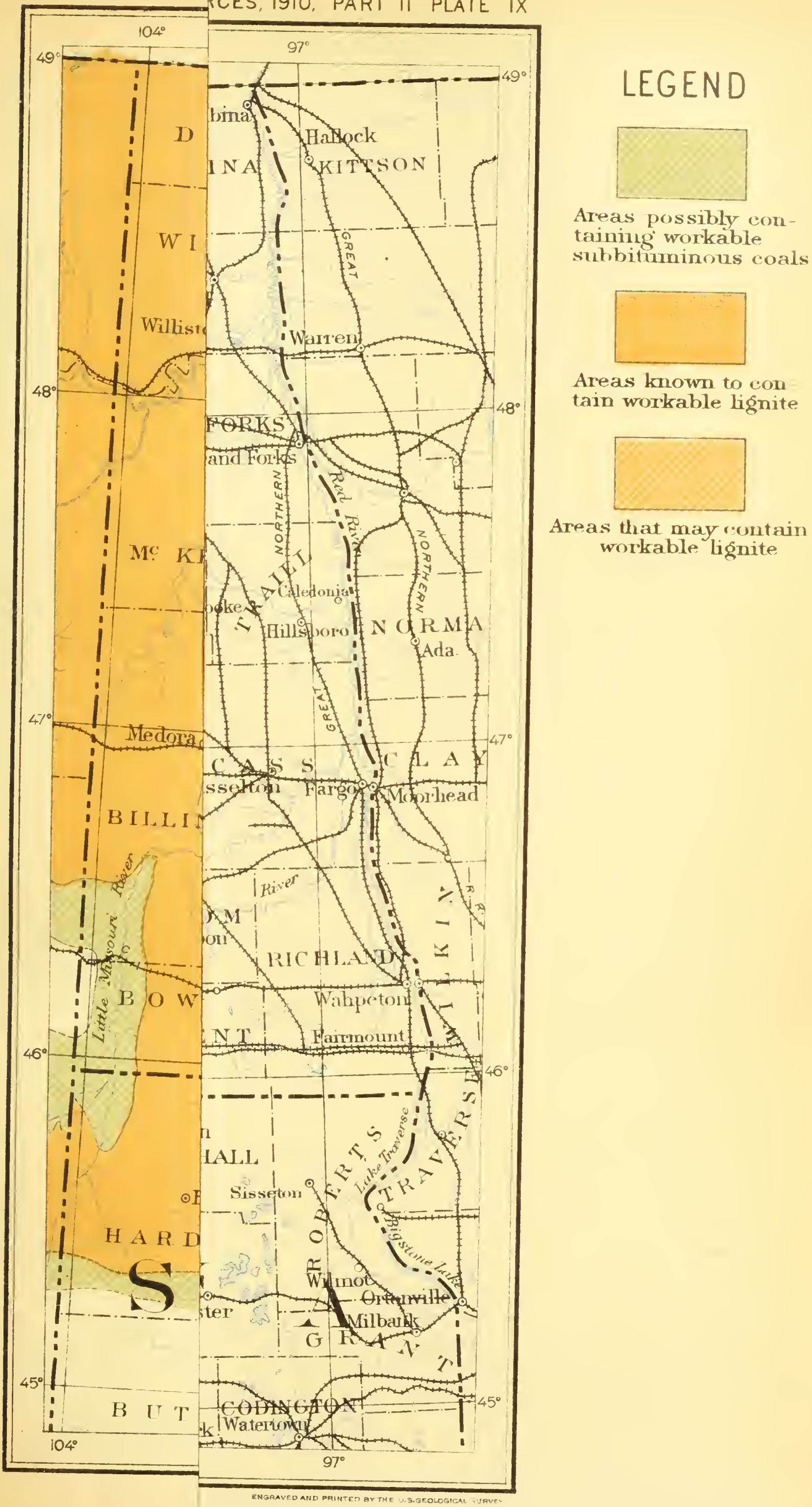
[a] Includes Emmons County.
[b] Includes Emmons and Oliver counties.
[c] Includes Adams, Bowman, Emmons, Hettinger, and Mercer counties.
[d] Includes Adams, Emmons, Hettinger, and Oliver counties.

According to the reports of the North Dakota Geological Survey, 97 townships contain in some part of their area at least one bed of lignite 7 feet or more in thickness, and at least 100 other townships contain beds from 4 to 7 feet thick. The lignite is generally well exposed along such streams as Big and Little Missouri, Knife, Heart, and Mouse rivers. Mining is carried on to some extent at most of the towns along the Northern Pacific Railway west of Mandan, on the Minneapolis, St. Paul & Sault Ste. Marie Railway in the Mouse River valley and also north of Bismarck, and to a small extent along the Great Northern Railway near Minot and Williston and along the Chicago, Milwaukee & Puget Sound Railway in the southwestern part of the State. The total area underlain by lignite-bearing beds is estimated to be 35,000 square miles.

The lignite is brown and generally woody, and as it comes from the mine contains about 40 per cent of moisture. Upon exposure to the atmosphere the lignite loses some of this moisture, and as a result it "slacks" or crumbles to pieces. If exposed indefinitely it breaks down to a fine powder, with probably considerable oxidation and loss of volatile combustible matter.

On account of its heavy percentage of moisture and rapid disintegration on exposure it does not stand transportation well, and consequently its field of usefulness is limited. So far its principal use has been to supply fuel to the settlers on the treeless plains in the western part of the State, and for that purpose it has been mined in a crude way in almost every county in the lignite-bearing area. Commercial mines are situated on the lines of railway, and these supply the towns of the State with fuel for domestic purposes and for use under steam boilers. On account, however, of the large percentage of moisture contained in the lignite it has difficulty in meeting competition with Pennsylvania and West Virginia coals, which find their way into this country via the Great Lakes.

Lignite has doubtless been mined and used in North Dakota by ranchmen and others since the time when North Dakota was a Terri-



ENGRAVED AND PRINTED BY THE U.S. GEOLOGICAL SURVEY

COAL FIELDS OF OHIO

Scale $\frac{1}{2500000}$

25 0 25 50 75 100 Miles

1911

tory, but it was not until 1884 that any record of production was obtained. This was published in the volume, Mineral Resources of the United States, covering that year. The production since 1884 is given in the following table:

Production of coal in North Dakota from 1884 to 1910, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1884	35,000	1892	40,725	1900	129,883	1908	320,742
1885	25,000	1893	49,630	1901	166,601	1909	422,047
1886	25,955	1894	42,015	1902	226,511	1910	399,041
1887	21,470	1895	38,997	1903	278,645		
1888	34,000	1896	78,050	1904	271,928	Total.	3,926,088
1899	28,907	1897	77,246	1905	317,542		
1890	30,000	1898	83,895	1906	305,689		
1891	30,000	1899	98,809	1907	347,760		

THE LIGNITE FIELDS OF NORTH DAKOTA.

Almost the entire western half of North Dakota is underlain by lignite-bearing formations, as shown on the accompanying map (Pl. IX). The most important of these formations is the Fort Union, which constitutes the hard rocks underlying most of this great area. Below the Fort Union is the Lance formation which contains beds of lignite that, in general, are too thin to be considered, but in places may be classed as workable. On the map the lignite field is represented as being divided into two parts, corresponding to the outcrop of these two formations, as follows: (1) Fort Union formation, containing beds of lignite over 3 feet in thickness and pure enough to be considered marketable, and (2) Lance formation which, in general, does not contain beds thick enough to work but may do so in certain localities.

The Lance formation is not known in the northern part of the State, but covers a large area from Bismarck southward to the South Dakota line, and also a small area in the southwestern corner of the State where it is brought to the surface by the Glendive anticline. There is also a small area of coal-bearing rocks in the Turtle Mountains in Bottineau and Rolette counties.

In the Fort Union formation the beds of lignite vary in thickness from a few inches to 30 feet. It was formerly supposed that these beds were lenticular in shape and that it was impossible to trace the outcrop of one for more than a mile or two. Recent work, however, has shown that this is not true; that the beds are continuous for many miles; and that their apparent lack of continuity is due to poor exposures of their outcrop. Carl D. Smith reports that one of these beds was actually traced a distance of 12 miles, and Prof. Leonard, State geologist, notes in one of his reports that one bed was followed by him for a distance of 24 miles.

OHIO.

Total production in 1910, 34,209,668 short tons; spot value, $35,932,288.

Although more than half of the coal miners of Ohio were on strike in1910 for a period equivalent to 25 per cent of the average number of days worked, the increase in production in 1910 over 1909 was the largest gain ever made in one year. In 1909 Ohio produced 27,939,641 short tons of coal, valued at $27,789,010; in 1910 the production increased to 34,209,668 tons, valued at $35,932,288. The increase was 6,270,027 short tons, or 22.44 per cent, in quantity and $8,143,278, or 29.3 per cent, in value. It was due principally, of course, to the long-continued idleness in the States to the west, but in addition to the influences exerted by the strike the cold winter of 1909–10 had cleared the Lake docks in the Northwest of coal, so that the year opened with a good demand for Ohio coal and there was exceptional activity during the year, except for the comparatively short time of the strike in the organized mines and two local strikes of eight months' duration in the Crooksville or "Thin Vein" Hocking district and in the Goshen or Middle Ohio district.

Production increased in 20 of the 28 coal-producing counties in the State and decreased in 8. The most notable increase was made in Belmont County, whose output gained 2,203,446 short tons. Guernsey County ranked second in increased production, with a gain of 1,601,617 tons. Athens County showed an increase of 1,462,290 tons; and the Hocking Valley district, comprising Athens, Hocking, and Perry counties, showed a total gain of 2,052,961 tons. One other county, Jefferson, added over a million tons to its output in 1909, with an increase of 1,333,563 tons. The principal decrease was in Tuscarawas County, which fell off nearly 50 per cent, from 1,577,303 tons in 1909 to 816,189 tons in 1910.

Ohio continues to lead in the percentage of the total production undercut by the use of machines. In 1910, 28,887,241 short tons, or 84.44 per cent of the total, was machine mined, against 22,148,216 tons, or 79.5 per cent of the total, in 1909. The increase in the total production of Ohio in 1910 was 6,270,027 short tons, and the increase in the quantity of coal mined by machines was 6,739,025 tons. There was not the same proportion of increase in the number of machines in use, as there were 1,452 in 1910 against 1,433 in 1909, a gain of 19. Machines of the chain-breast pattern have the greatest popularity in Ohio, 1,324 of the 1,452 in use in 1910 being of that type. Of the others, 104 were punchers and 24 were long-wall machines. The average production for each machine in 1910 was 19,895 tons, the best record made in the United States.

The number of men employed in the coal mines of Ohio in 1910 was 46,641, who averaged 203 working days. Had it not been for the time lost by strikes the mine workers in Ohio would have averaged about 230 working days. The record for efficiency among the miners in Ohio is, however, high. In 1910 the average production by each man employed was 733 tons for the year and 3.61 tons for each working day.

Mr. George Harrison, the State mine inspector, reports that in 1910 there were 161 men killed and 471 injured in the coal mines of Ohio. The death rate per thousand was 3.45, and there were 212,482 tons of coal mined for each life lost, against a death rate per thousand of 2.45 and 241,358 short tons mined for each fatality in 1909.

The statistics of production, by counties, in 1909 and 1910, with the distribution of the product for consumption, are shown in the following table:

Coal production of Ohio in 1909 and 1910, by counties, in short tons.

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.
Athens	3,922,602	46,654	162,014	....	4,131,270	$4,073,509	$0.99	....	....
Belmont	5,817,249	176,398	67,926	....	6,061,573	5,297,500	.88	....	....
Carroll	349,344	30,985	9,944	....	390,273	375,640	.96	....	....
Columbiana	574,246	69,261	13,778	....	657,285	734,081	1.12	....	....
Coshocton	334,466	33,328	6,187	....	373,981	430,225	1.15	....	....
Gallia	5,650	2,050	....	....	7,700	8,700	1.13	....	....
Guernsey	3,031,085	6,311	47,981	....	3,085,377	2,765,720	.90	....	....
Harrison	540,709	28,364	7,890	....	576,963	487,226	.84	....	....
Hocking	1,137,549	537	56,809	....	1,194,895	1,198,625	1.00	....	....
Holmes	1,017	11,852	17	....	12,886	17,019	1.32	....	....
Jackson	713,611	44,038	26,814	....	784,463	1,270,265	1.62	....	....
Jefferson	3,550,481	283,234	73,577	826	3,908,118	3,644,497	.93	....	....
Lawrence	137,833	45,029	2,078	....	184,940	238,089	1.29	....	....
Mahoning	31,252	9,042	610	....	40,904	63,002	1.54	....	....
Medina	4,813	6,957	1,247	....	13,017	21,343	1.64	....	....
Meigs	487,870	70,739	6,295	....	564,904	618,447	1.09	....	....
Muskingum	363,231	121,436	2,512	....	487,179	469,574	.96	....	....
Noble	367,079	4,101	4,177	....	375,357	320,491	.85	....	....
Perry	2,034,260	48,724	50,282	....	2,133,266	2,149,050	1.01	....	....
Stark	344,999	112,318	28,955	....	486,272	798,581	1.64	....	....
Summit	65,936	8,198	10,738	....	84,872	143,328	1.69	....	....
Tuscarawas	1,343,829	195,563	37,911	....	1,577,303	1,606,081	1.02	....	....
Vinton	133,043	14,744	4,167	....	151,954	172,036	1.13	....	....
Wayne	79,034	12,066	9,950	....	101,050	165,188	1.63	....	....
Other counties [a] and small mines.	286,773	261,966	5,100	....	553,839	720,793	1.30	....	....
Total	25,657,961	1,643,895	636,959	826	27,939,641	27,789,010	.99	....	38,114

1910.

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	5,413,707	61,191	113,462	5,200	5,593,560	$6,183,974	$1.11	190	7,406
Belmont	7,981,477	191,793	91,749	....	8,265,019	7,896,992	.96	233	9,360
Carroll	265,985	41,711	5,821	....	313,517	338,223	1.08	191	748
Columbiana	649,929	51,415	13,908	....	715,252	796,558	1.11	254	994
Coshocton	383,694	38,844	4,803	....	427,341	513,498	1.20	223	663
Gallia	6,737	2,450	....	....	9,187	11,182	1.22	71	69
Guernsey	4,578,059	30,775	78,160	....	4,686,994	4,295,136	.92	233	5,023
Harrison	534,063	18,254	8,620	....	560,937	526,983	.94	224	700
Hocking	1,593,127	25,794	16,654	....	1,635,575	1,792,997	1.10	188	2,491
Holmes	482	9,519	156	....	10,157	12,645	1.24	215	21
Jackson	734,688	115,385	28,583	....	878,656	1,423,960	1.62	164	2,224
Jefferson	4,865,624	293,566	81,742	749	5,241,681	5,232,691	1.00	228	6,006
Lawrence	100,739	47,153	676	....	148,568	187,421	1.26	165	425
Mahoning	37,964	21,705	765	....	60,434	95,685	1.58	196	156
Medina	16,488	6,660	1,000	....	24,148	39,314	1.63	179	40
Meigs	552,592	41,424	5,476	....	599,492	716,362	1.19	225	972
Muskingum	158,686	79,350	759	....	238,795	252,135	1.06	120	677
Noble	417,305	5,884	5,375	....	428,564	393,616	.92	245	480
Perry	2,190,291	58,936	34,030	....	2,283,257	2,405,254	1.05	183	3,367
Stark	334,126	139,910	22,473	....	496,509	826,786	1.67	167	1,157
Summit	88,972	3,628	8,643	....	101,243	154,290	1.52	195	189
Tuscarawas	642,690	157,561	15,938	....	816,189	841,333	1.03	115	2,120
Vinton	60,403	23,578	2,820	....	86,801	96,611	1.11	162	186
Wayne	126,756	19,805	12,577	....	159,138	302,477	1.90	151	380
Other counties [a] and small mines.	224,401	198,153	6,100	....	428,654	596,165	1.39	130	787
Total	31,958,985	1,684,444	560,290	5,949	34,209,668	35,932,288	1.05	203	46,641

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

The statistics of production, by counties, during the last five years, with increase and decrease in 1910 as compared with 1909, are shown in the following tables:

Coal production of Ohio, 1906–1910, by counties, in short tons.

County.	1906	1907	1908	1909	1910	Increase (+) or decrease (−), 1910.
Athens	4,003,074	4,562,694	3,967,318	4,131,270	5,593,560	+ 1,462,290
Belmont	4,266,865	6,208,188	5,593,777	6,061,573	8,265,019	+ 2,203,446
Carroll	195,713	367,062	366,748	390,273	313,517	− 76,756
Columbiana	607,417	709,515	509,045	657,285	715,252	+ 57,967
Coshocton	367,600	403,015	364,028	373,981	427,341	+ 53,360
Gallia	47,495	35,195	11,450	7,700	9,187	+ 1,487
Guernsey	3,273,838	3,970,921	2,939,550	3,085,377	4,686,994	+ 1,601,617
Harrison	280,232	499,300	464,676	576,963	560,937	− 16,026
Hocking	1,793,112	1,648,581	1,434,036	1,194,895	1,635,575	+ 440,680
Holmes	39,465	22,165	15,009	12,886	10,157	− 2,729
Jackson	1,369,800	1,284,877	836,328	784,463	878,656	+ 94,193
Jefferson	4,515,420	4,528,006	3,591,016	3,908,118	5,241,681	+ 1,333,563
Lawrence	177,145	243,027	171,307	184,940	148,568	− 36,372
Mahoning	117,989	94,335	67,312	40,904	60,434	+ 19,530
Medina	73,119	46,071	11,407	13,017	24,148	+ 11,131
Meigs	429,435	330,503	449,969	564,904	599,492	+ 34,588
Morgan	223,625	321,793	268,106	191,391	124,336	− 67,055
Muskingum	282,348	414,121	430,653	487,179	238,795	− 248,384
Perry	2,557,588	2,901,147	2,146,995	2,133,266	2,283,257	+ 149,991
Portage	96,467	95,462	89,906	100,497	101,826	+ 1,329
Stark	579,640	687,866	501,920	486,272	496,509	+ 10,237
Summit	104,216	104,236	98,641	84,872	101,243	+ 16,371
Trumbull	....	1,000	1,000	620	700	+ 80
Tuscarawas	1,413,751	1,797,399	1,358,129	1,577,303	816,189	− 761,114
Vinton	210,984	254,529	138,545	151,954	86,801	− 65,153
Wayne	215,031	185,260	96,431	101,050	159,138	+ 58,088
Noble, Scioto	401,316	314,761	208,899	381,327	438,398	+ 57,071
Small mines	88,955	[a] 111,390	138,438	255,361	191,958	− 63,403
Total	27,731,640	32,142,419	26,270,639	27,939,641	34,209,668	+ 6,270,027
Total value	$30,346,580	$35,324,746	$27,897,704	$27,789,010	$35,932,288	+$8,143,278

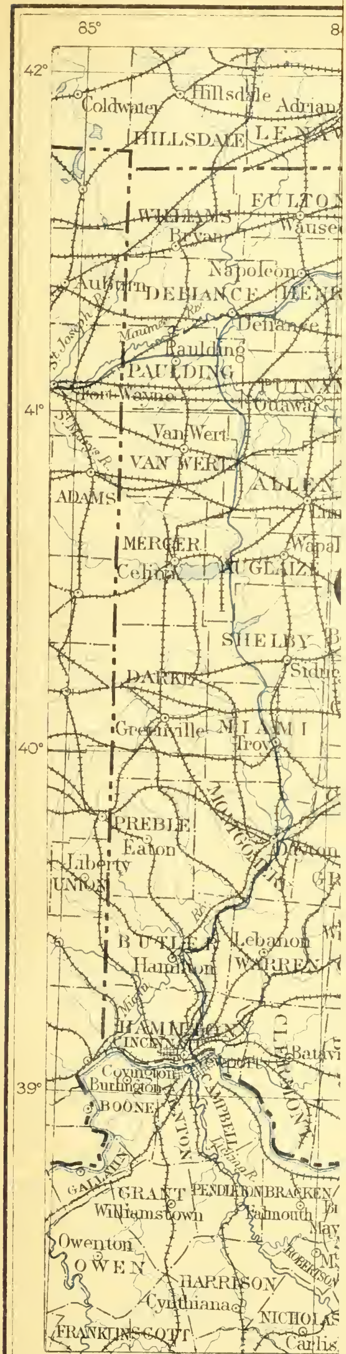
[a] Includes production of Monroe County.

A statement of the annual production of coal in Ohio from 1838 to the close of 1910 will be found in the following table:

Production of coal in Ohio from 1838 to 1910, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1838	119,952	1857	975,000	1876	3,500,000	1895	13,355,806
1839	125,000	1858	1,000,000	1877	5,250,000	1896	12,875,202
1840	140,536	1859	1,060,000	1878	5,500,000	1897	12,196,942
1841	160,000	1860	1,265,600	1879	6,000,000	1898	14,516,867
1842	225,000	1861	1,150,000	1880	6,008,595	1899	16,500,270
1843	280,000	1862	1,200,000	1881	9,240,000	1900	18,988,150
1844	340,000	1863	1,204,581	1882	9,450,000	1901	20,943,807
1845	390,000	1864	1,815,622	1883	8,229,429	1902	23,519,894
1846	420,000	1865	1,536,218	1884	7,640,062	1903	24,838,103
1847	480,000	1866	1,887,424	1885	7,816,179	1904	24,400,220
1848	540,000	1867	2,092,334	1886	8,435,211	1905	25,552,950
1849	600,000	1868	2,475,844	1887	10,300,708	1906	27,731,640
1850	640,000	1869	2,461,986	1888	10,910,951	1907	32,142,419
1851	670,000	1870	2,527,285	1889	9,976,787	1908	26,270,639
1852	700,000	1871	4,000,000	1890	11,494,506	1909	27,939,641
1853	760,000	1872	5,315,294	1891	12,868,683	1910	34,209,668
1854	800,000	1873	4,550,028	1892	13,562,927		
1855	890,000	1874	3,267,585	1893	13,253,646	Total	581,189,306
1856	930,000	1875	4,864,259	1894	11,909,856		

U.S. GEOLOGICAL SURVEY
GEORGE OTIS SMITH, DIRECT



COAL FIELDS OF PENNSYLVANIA

Scale $\frac{1}{2500000}$

25 0 25 50 75 100 Miles

1911

Bituminous fields

Anthracite fields

THE COAL FIELDS OF OHIO.

The areas in Ohio (Pl. X) now or formerly underlain by coal are estimated at 12,660 square miles. Much of the coal, however, has been exhausted, and the workable areas at the present time are much below this figure. The coal-bearing formations contain at least 16 different coal beds within this State. Of these, 6 are important and have been developed on a large scale, but the other 10 have been developed principally by small mines, a large part of the output of which is sold for local consumption. The important productive coal beds are the block (Sharon coal), or No. 1; Wellston, or No. 2; Lower Kittanning, No. 5; Middle Kittanning, No. 6; Upper Freeport, No. 7; Pittsburgh, No. 8; Pomeroy; and Meigs Creek.

Some of the coals of Ohio are celebrated for certain uses. That (No. 6) of the Hocking Valley region, which is contained in Perry, Athens, and Hocking counties, is a free, open-burning coal, highly regarded as a steam and domestic coal, but more popular as a furnace fuel, for which purpose it is used raw. The Hocking Valley coal belongs to the Middle Kittanning, or No. 6 bed. The No. 7, or Upper Freeport, which is mined in Muskingum, Gallia, Lawrence, and Guernsey counties and in portions of Perry County, is a high-grade steam fuel and would make, except for its high content of sulphur, an excellent coke. On account of the high sulphur, however, no coke is made from this coal in the State. The Pittsburgh bed, or No. 8 of the State survey nomenclature, lies in Jefferson, Harrison, Belmont, Guernsey, Noble, Monroe, Athens, Morgan, Meigs, and Gallia counties. The four counties last named, which constitute a southern area, furnish but a small production. The Pittsburgh coal is the base of the Monongahela formation ("Upper Productive Coal Measures") in the State, and is the most important of all the beds within these measures. The Pomeroy coal (correlated with the Redstone coal of Pennsylvania) lying 20–55 feet above the Pittsburgh bed, is worked in Meigs, Gallia, and Lawrence counties, its principal production, about 500,000 tons annually, being derived from Meigs County. The Meigs Creek coal, 80 to 100 feet above the Pittsburgh bed, is correlated with the Sewickley bed of western Pennsylvania. It is workable in portions of Morgan, Noble, Washington, Muskingum, Harrison, Belmont, and Monroe counties, and will ultimately prove a most valuable reserve, though its variable thickness and lower grade subordinate it to the Pittsburgh, and its exploitation is at present local and generally on a small scale.

Coal No. 1, or the block coal, is mined in the northeastern counties of the State, especially in Summit, Stark, and Mahoning counties, and a small quantity in Portage County. This coal is very pure and is used principally in making pig iron, for which it is used in its raw state in the blast furnace. It was this coal which first supplanted charcoal in the blast furnaces of the State. It is dry, free burning, and does not coke. The Massillon coal, highly prized for domestic purposes in Cleveland and other cities on the Lakes, is obtained from this bed. The Wellston bed, which lies above the block, is the most important producing bed in the southwestern portion of the Ohio field. The mines in Jackson County, at Jackson and Wellston, are worked on this bed.

One of the early reports published by Ohio states that in 1838 there were 119,952 short tons produced from the coal mines of the State. It is probable that some coal was mined in Ohio prior to that date, but we have no record of such production. The United States Census of 1840 credited Ohio with an output of 140,536 tons. The census of 1850 did not consider the coal-mining industry, and the next report we have of coal production in the State was that of the census of 1860, which recorded an output of 1,265,600 short tons. The production since 1838 is given in the table on a preceding page, showing the production of coal in the United States from the earliest recorded mining to the close of 1910.

Marius R. Campbell, in his report on the coal fields of the United States, estimates that there were 86,028,000,000 short tons in the original coal supply of Ohio. The total production of the State to the close of 1910 was 581,189,306 tons, of which the production in that year amounted to 34,209,668, or 5.89 per cent. The total output to the close of 1910 represents an exhaustion of 872,000,000 short tons, or about 1 per cent of the estimated original supply.

OKLAHOMA.

Total production in 1910, 2,646,226 short tons; spot value, $5,867,947.

Oklahoma was one of the States most seriously affected by the prolonged strike of 1910. In anticipation of the suspension of work the mines of the Mississippi Valley region were operated with unusual activity during the first three months of the year and about a 50 per cent increase over the normal tonnage was won during that time. After mining was generally resumed in September there was a strong effort made by both operators and miners to make up for lost time. Thus it is that although the strike lasted for five and a half months and considerable additional time was required to put the mines into working order the actual loss in production was not in proportion to the time lost by the strike. In Oklahoma the production decreased from 3,119,377 short tons, valued at $6,253,367, in 1909 to 2,646,226 tons, valued at $5,867,947, in 1910, a difference against 1910 of 473,151 short tons, or 15.17 per cent, in quantity and of $385,420, or 6.16 per cent, in value. Because of the shortage caused by the strike the average price per ton advanced from $2 in 1909 to $2.22 in 1910.

The suspension of mining in the Southwestern States gave exceptional opportunity for coals from Colorado, New Mexico, and Alabama to make new and heavy inroads upon the markets naturally tributary to Oklahoma and the adjoining States of Arkansas and Kansas. It also gave substantial encouragement to the development of lignite in Texas, and to the expansion of its use, but probably the most serious effect, because more lasting, was the migration of the miners to other States where mining was not interrupted. Consequently when mining was resumed and demand was unprecedently heavy the labor supply was entirely inadequate. The car supply was good, particularly in Arkansas and Oklahoma, but as the mines could not be operated to normal capacity the railroad equipment was directed to other districts. Mining conditions are somewhat more exacting in Arkansas and Oklahoma than in other States with the product of which the coals of Arkansas and Oklahoma have to compete, and although the mining rates are higher the labor is less attractive, and some time must elapse before the working places are filled.

The industry in Arkansas and Oklahoma has suffered from other troubles than the strike. There has been a strong tendency on the part of the miners to use increased quantities of powder, and it is also stated that dynamite is frequently used, a practice which is not only dangerous to life and property but results in a largely increased percentage of slack. Moreover, it is the practice in nearly all the mines to shoot from the solid. This also is extra hazardous and has increased the quantity of slack, so that it is now double what it was 15 years ago. This results in the complaint by purchasers that coal which appears to be lump coal on arrival easily disintegrates as a result of the crushing strain to which it has been subjected by the mining methods employed.

In addition to the other disorganizing influences the coal industry of the Southwest has suffered from the continued competition of cheap fuel oil and of natural gas. The industry in Arkansas is expecting to lose a considerable portion of its business from the piping of gas from the Caddo field of Louisiana to Little Rock, Hot Springs, Pine Bluff, and intermediate points.

The number of men reported as employed in the coal mines of Oklahoma in 1910 was 8,657, who worked an average of 144 days. The number of men on strike was 8,213 and the average time lost by each was 152 days, so that the idleness was equivalent to 99 per cent of the time worked. The quantity of coal produced for each man employed in 1910 was 306 short tons for the year and 2.13 tons for each working day. In 1908 the average production per man was 341 short tons for the year and 1.98 tons for each working day. The 8-hour day prevails, though two mines in 1910 were operated 10 hours a day.

On account of the pernicious and dangerous practice of "shooting from the solid" (encouraged, unfortunately, by laws which compel the payment for mining on a mine-run basis), there is little, if any, coal properly undercut in the State of Oklahoma, and no undercutting machines are employed.

The statistics of production in 1909 and 1910, by counties, are shown in the following table:

Coal production of Oklahoma in 1909 and 1910, by counties, in short tons.

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.
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

Coal production of Oklahoma in 1909 and 1910, by counties, in short tons—Continued.

1910.

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.
Coal	469,062	8,390	21,206	......	498,658	$1,071,644	$2.15	145	2,000
Haskell and Latimer	617,815	3,336	49,031	5,771	675,953	1,360,978	2.01	165	1,868
Le Flore	80,289	1,327	6,012	......	87,628	139,351	1.59	111	293
Okmulgee	212,858	9,318	4,931	......	227,107	441,110	1.94	143	619
Pittsburg	989,576	21,502	72,165	......	1,083,243	2,672,582	2.47	134	3,752
Other counties [a]	66,387	936	302	......	67,625	164,934	2.44	203	125
Small mines	....	6,012	....	......	6,012	17,348	2.89	......	....
Total	2,435,987	50,821	153,647	5,771	2,646,226	5,867,947	2.22	144	8,657

[a] Includes Rogers, Tulsa, and Wagoner.

The year 1908 was the first for which it was possible to give the production of Oklahoma (formerly Indian Territory) by counties, it having been organized as a State and admitted into the Union in 1906. The production by counties in 1908, 1909, and 1910, with increase and decrease in 1910 compared with 1909, is shown in the following table:

Coal production of Oklahoma in 1908, 1909, and 1910, by counties, in short tons.

County.	1908	1909	1910	Increase(+) or decrease (−), 1910.
Coal	576,746	658,159	498,658	− 159,501
Haskell and Latimer	674,636	738,806	675,953	− 62,853
Le Flore	187,624	128,376	87,628	− 40,748
Okmulgee	172,934	262,310	227,107	− 35,203
Pittsburgh	1,294,936	1,271,109	1,083,243	− 187,866
Rogers and Wagoner	....	14,556	27,618	+ 13,062
Tulsa	39,848	39,834	40,007	+ 173
Small mines	1,392	6,227	6,012	− 215
Total	2,948,116	3,119,377	2,646,226	− 473,151
Total value	$5,976,504	$6,253,367	$5,867,947	−$385,420

The Tenth United States Census (1880) contains the first published record of coal production 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 Territory earlier than 1880. The maximum production, 3,642,658 short tons, was obtained in the boom year 1907, but as shown in the following table the industry during the last nine years has been practically stationary and has not shown the development and progress exhibited in other States:

Production of coal in Oklahoma from 1880 to 1910, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1880	120,947	1889	752,832	1898	1,381,466	1907	3,642,658
1881	150,000	1890	869,229	1899	1,537,427	1908	2,948,116
1882	200,000	1891	1,091,032	1900	1,922,298	1909	3,119,377
1883	350,000	1892	1,192,721	1901	2,421,781	1910	2,646,226
1884	425,000	1893	1,252,110	1902	2,820,666		
1885	500,000	1894	969,606	1903	3,517,388	Total	48,558,734
1886	534,580	1895	1,211,185	1904	3,046,539		
1887	685,911	1896	1,366,646	1905	2,924,427		
1888	761,986	1897	1,336,380	1906	2,860,200		

THE COAL FIELDS OF OKLAHOMA.[1]

The coal-bearing rocks of Oklahoma (Pl. II) form a part of the western interior coal field. They extend from what was Indian Territory into Kansas on the north and into Arkansas on the east. Within the State this field has an approximate area of 20,000 square miles, underlying the western half of the area formerly known as the Cherokee Nation, the whole of what was the Creek Nation, the northern third of what was the Choctaw Nation, and a small portion of the former Chickasaw Nation. The total area underlain by workable coal is estimated to be about 10,000 square miles.

At present the entire production is from what were formerly known as the Cherokee, Creek, and Choctaw nations, the last named contributing by far the largest portion.

The coal-bearing rocks of Oklahoma belong to the Pennsylvanian series of the Carboniferous. The coals, of which there are 10 or more beds, vary from a medium low on the one hand to high-grade bituminous, approaching semianthracite, on the other. Some of the high-grade bituminous varieties possess coking qualities. Several hundred ovens are in operation in the eastern and western parts of what was the Choctaw field. Much of the slack that is produced is washed and turned into coke.

The greater portion of the development in Oklahoma has been in the former Choctaw Nation, accessible to the Missouri, Kansas & Texas, the St. Louis & San Francisco, and the Kansas City Southern railroads, which cross Oklahoma north and south, and to the Choctaw, Oklahoma & Gulf and the Midland Valley railroads, which cross the State from east to west.

OREGON.

Total production in 1910, 67,533 short tons; spot value, $235,229.

The coal-mining industry of Oregon is suffering from the great increase in the production of petroleum in California and its use for domestic fuel as well as on railroads and for manufacturing. The production of coal in Oregon decreased from 87,276 short tons in 1909 to 67,533 tons in 1910, a loss of 19,743 tons, or 22.62 per cent, whereas the value increased $144, or 0.06 per cent, from $235,085 in 1909 to $235,229 in 1910. 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. 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 has been able to compete to some extent in that city with the higher grades of coals from Washington, British Columbia, the Rocky Mountain States, and Australia.

There were 153 men employed for an average of 257 days in the lignite mines of Oregon in 1910. There were no strikes or other labor troubles.

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[1] See map accompanying description of Arkansas fields.

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, 1906–1910, 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.
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
1910	40,497	13,583	13,453	67,533	235,229	3.48	257	153

Coal was first noted in the Coos Bay region about 50 years ago, Prof. J. S. Newberry having reported in 1855 that the coal deposits of Coos Bay had begun to attract attention.

The first cargo was shipped from the Empire Basin, but the discovery of coal near the head of Coos Bay soon transferred the point of production to Newport which remained the principal mine until within the last decade, since the Beaver Hill mine has been more successfully managed and become the chief producer. 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 1910 has amounted to 2,031,460 short tons, as is shown in the following table:

Production of coal in Oregon, 1880–1910, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1880	43,205	1889	64,359	1898	58,184	1907	70,981
1881	33,600	1890	61,514	1899	86,888	1908	86,259
1882	35,000	1891	51,826	1900	58,864	1090	87,276
1883	40,000	1892	34,661	1901	69,011	1910	67,533
1884	45,000	1893	41,683	1902	65,648		
1885	50,000	1894	47,521	1903	91,144	Total	2,031,460
1886	45,000	1895	73,685	1904	111,540		
1887	37,696	1896	101,721	1905	109,641		
1888	75,000	1897	107,289	1906	79,731		

THE COAL FIELDS OF OREGON.

The only productive coal field in Oregon (fig. 5) is situated in the southwestern part of the State, in Coos County, and is known as the Coos Bay field, from the fact that it entirely surrounds that body of water. It occupies a total area of about 230 square miles, its length north and south being about 30 miles and its maximum breadth at the middle about 11 miles, tapering regularly toward both ends. Other coal fields have been prospected in different parts of the State. Among these are the Upper Nehalem field, in Columbia County; the Lower Nehalem, in Clatsop and Tillamook counties; the Yaquima field in

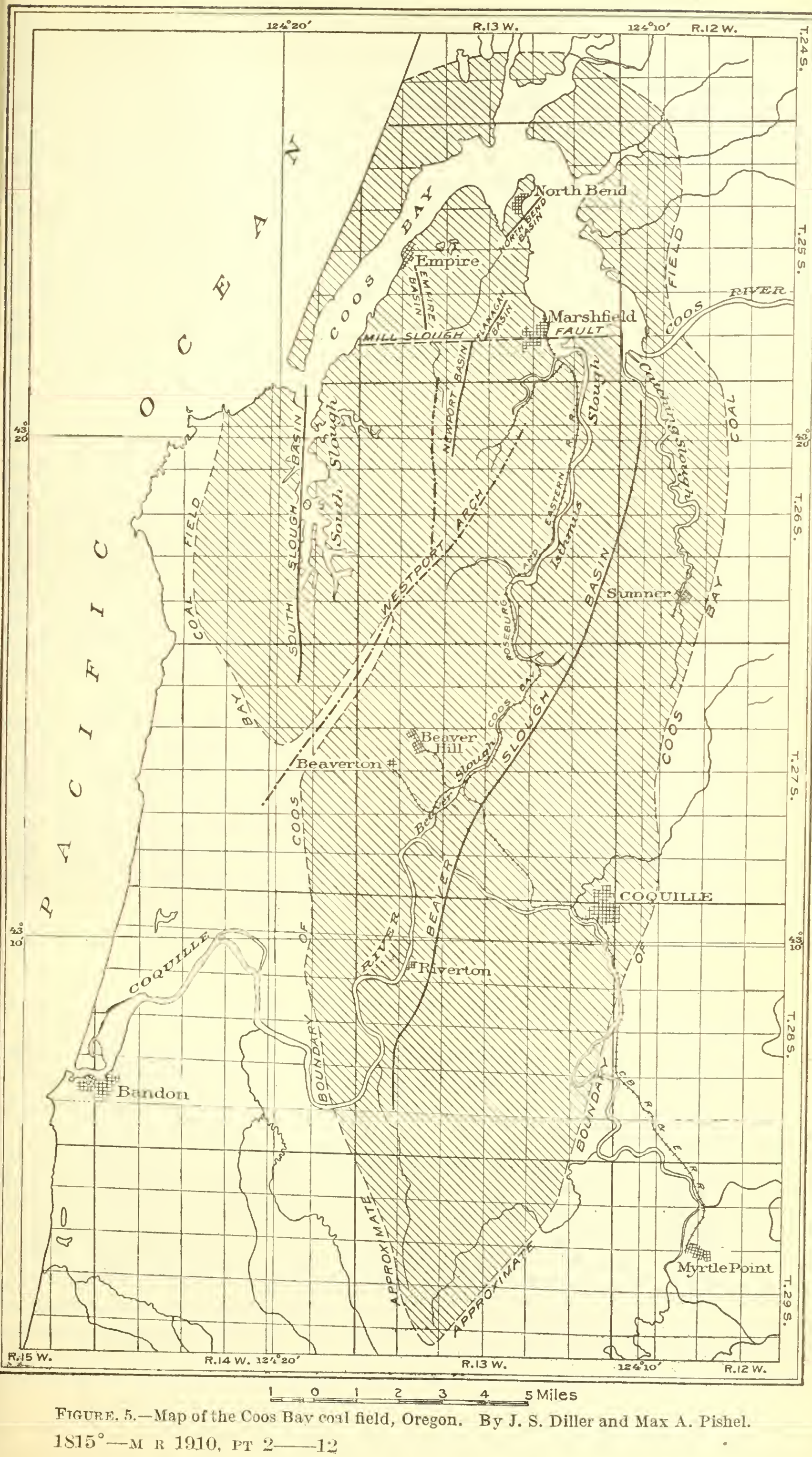


FIGURE. 5.—Map of the Coos Bay coal field, Oregon. By J. S. Diller and Max A. Pishel.

Lincoln County; the Eckley and Shasta Costa fields, in Curry County; the Eden field, in Coos County; and the Rogue River valley field, in Jackson County. All of these fields lie west of the Cascade Range, but none has been developed to the point of production. Another field has been located in the basin of the John Day River, east of the Cascade Range, but little is knows concerning it. All of the fields west of the range, with the exception of the Coos Bay, are of limited area, the largest, outside of the Coos Bay, being the Upper Nehalem, which has an area of less than 20 square miles. All of the coal of these fields is lignitic in character, except the best coals of Coos Bay which are properly regarded as subbituminous. Transportation is confined exclusively to Coos Bay and the Pacific Ocean, and San Francisco is the principal market. The Coos Bay field as shown on the accompanying map is divided by the Westport arch and it branches into six basins known as the Beaver Slough, the South Slough, the Newport, the Flanagan, the North Bend, and the Empire. The Beaver Slough with comparatively gentle dips is by far the largest and most valuable coal basin, with active mines at Beaver Hill, Riverton, and near Coquille, as well as less important openings farther north. The Newport Basin, elevated over an angle of the Westport arch, is most favorably located for economic mining and has been worked more or less continuously for many years. It approaches exhaustion except at the northern end, where the South Marshfield mine still contributes to the local and the coast trade. The Flanagan and the North Bend basins are small and supply part of the local demands, and a small amount is mined for local use in the South Slough.

The coal production in Oregon during recent years has been adversely affected by the great increase in the production of petroleum in California and its use for fuel purposes. As practically all of the product from Coos Bay has been shipped by water to San Francisco, the substitution of oil for coal in most of the manufacturing industries has cut off a considerable portion of the market for this coal. The effect upon Oregon's production is shown in a decrease from 109,641 tons in 1905 to 67,533 tons in 1910.

PENNSYLVANIA.

Total production in 1910, 235,006,762 short tons; spot value, $313,304,812.

Anthracite.—Total production in 1910, 75,433,246 long tons (equivalent to 84,485,236 short tons); spot value, $160,275,302.

Bituminous.—Total production in 1910, 150,521,526 short tons; spot value, $153,029,510.

In the combined production of anthracite and bituminous coal Pennsylvania outranks any of the coal-producing countries of the world except Great Britain and Germany, and in 1910 came within 10,000,000 short tons, or less than 5 per cent, of equaling the output of Germany. Pennsylvania production in 1910 was more than four times that of Austria-Hungary in 1909 (the latest year for which the statistics of that empire are available), more than five times that of France in 1910, and was nearly 20 per cent of the total coal production of the world. From 1829 to and including the first year of the present century Pennsylvania contributed over 50 per cent of the total coal production of the United States and still produces between 45 and 50 per cent of the total, but the relative importance of Pennsylvania as a coal producer has steadily declined in recent years. In 1880 Pennsylvania produced 66 per cent of the total; in 1890 its percentage was 56; in 1900 it was 51, and in 1910 it was 46.9. This statement must not be taken as an indication of any decline in the coal-mining industry of Pennsylvania, for that industry has, particularly in the bituminous districts, kept pace with the manufacturing industries and has increased in considerably larger ratio than the population of the State and of the United States as a whole. The falling off in the relative importance of Pennsylvania has been due to the more rapid increase in the production of other States, notably in West Virginia, Illinois, Alabama, and in the Rocky Mountain States.

The following table shows the total production of the United States and of Pennsylvania since 1880, with the percentage of the total tonnage produced by Pennsylvania in each year:

Production of Pennsylvania coal compared with total production of the United States, 1880–1910, 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	1896	191,986,357	103,903,534	54
1881	85,881,030	54,320,018	63	1897	200,223,665	107,029,654	53
1882	103,285,789	57,254.507	55	1898	219,976,267	118,547,777	54
1883	115,212,125	62,488,190	54	1899	253,741,192	134,568,180	53
1884	119,735,051	62,404,488	52	1900	269,684,027	137,210,241	51
1885	110,957,522	62,137,271	56	1901	293,299,816	149,777,613	51
1886	112,743,403	62,857,210	56	1902	301,590,439	139,947,962	46
1887	129,975,557	70,372,857	54	1903	357,356,416	177,724,246	49.7
1888	148,659,402	77,719,624	52	1904	351,816,398	171,094,996	49
1889	141,229,514	81,719,059	58	1905	392,722,635	196,073,487	49.9
1890	157,770,963	88,770,814	56	1906	414,157,278	200,575,617	48.4
1891	168,566,668	93,453,921	55	1907	480,363,424	235,747,489	49.1
1892	179,329,071	99,167,080	55	1908	415,842,698	200.448,281	48.2
1893	182,352,774	98,038,267	54	1909	460,814,616	219,037,150	47.5
1894	170,741,526	91,833,584	54	1910	501,596,378	235,006,762	46.9
1895	193,117,530	108,216,565	56				

Compared with 1909, when the total production of the State amounted to 219,037,150 short tons, valued at $279,266,824, the production in 1910 shows an increase of 15,969,612 short tons, or 7 per cent, in quantity, and of $34,037,988, or 12.2 per cent, in value. Of the total increase, 3,048,997 long tons, or 3,414,877 short tons, was in the production of anthracite, from 72,384,249 long tons (81,070,359 short tons) in 1909 to 75,433,246 long tons (84,485,236 short tons) in 1910. The production of bituminous coal increased from 137,966,791 short tons in 1909 to 150,521,526 short tons in 1910, a gain of 12,554,735 short tons, or 9.1 per cent. The value of the anthracite production showed an increase of $11,093,715, or 7.4 per cent, and that of bituminous coal increased $22,944,273, or 17.64 per cent. It is to be observed that although the quantity of bituminous coal produced exceeded that of anthracite by nearly 80 per cent, the value of the anthracite product was larger than that of the bituminous output by nearly $7,250,000. Bituminous coal represented 64 per cent of the total output and anthracite represented 51 per cent of the total value.

The anthracite mines of Pennsylvania gave employment to 169,497 men, who worked an average of 229 days. The bituminous mines employed 175,403 men for an average of 238 days. That is to say, it took only 6,000 more men (less than 4 per cent) working an average of 9 more days (also about 4 per cent) to produce 80 per cent more coal in the bituminous region than in the anthracite. The average production for each man employed in the anthracite region was 498 short tons during the year. In the bituminous mines the men averaged 858 tons each. The daily average production for each employee in the anthracite region was 2.17 short tons and in the bituminous districts it was 3.61 tons.

According to James E. Roderick, chief of the Pennsylvania Department of Mines, there were 601 men killed and 1,050 injured in the anthracite mines in 1910. The fatalities in the bituminous mines numbered 539 and the nonfatal accidents were 1,142. The death rate per thousand in the anthracite mines was 3.55 and in the bituminous mines 3.07. For each life lost there were 140,574 short tons of anthracite and 279,261 tons of bituminous coal produced.

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 1910, with the percentage each bears to the total. It will be seen from this table that the average yearly production of anthracite during the last five years of this period—1906 to 1910—was 3.1 times the average yearly production from 1876 to 1880. The average yearly bituminous tonnage in the last five years was 10.2 times that of the first five years. From 1876 to 1880 anthracite production represented 41.44 per cent of the total and bituminous coal 58.56 per cent. From 1906 to 1910 the anthracite production averaged 17.85 per cent of the total and bituminous coal 82.15 per cent.

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
1906-1910	81,142,214	17.85	373,412,644	82.15

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 were shipped from the anthracite region. From 1814 to the close of 1910 the total production of anthracite had amounted to 1,946,717,383 long tons, or 2,180,323,469 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 1910 has amounted to 2,251,737,097 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 and 1910 exceeded that of anthracite by more than 122,000,000 short tons, the total production of bituminous coal now exceeds that of anthracite.

PENNSYLVANIA ANTHRACITE.

With the exception of the "boom" year, 1907, the production of anthracite in Pennsylvania in 1910 was the largest in the history of the industry. The quantity produced in 1910 was 75,433,246 long tons, an increase over 1909 of 3,048,997 long tons, or 4 per cent. The value increased from $149,181,587 in 1909 to $160,275,302, a gain of $11,093,715, or 7.4 per cent. The production in 1910 was within almost exactly 1,000,000 long tons of the maximum record for 1907, when the output amounted to 76,432,421 long tons. The value of the product in 1907 exceeded that of 1910 by $3,308,754. The average price per ton at the mines in 1910 was $2.12, against $2.06 in 1909, $2.13 in 1908, and $2.14 in 1907.

Of the total production in 1910, 65,735,024 long tons, or 87.1 per cent, were loaded at the mines for shipment to distant points; 1,804,082 tons, or 2.4 per cent, were sold to local trade and employees, and 7,894,140 tons, or 10.5 per cent, were consumed in the operation of the mines. In former years the colliery consumption was not considered as having any market value, consisting as it did of screenings, or culm, which unless so used was wasted. More recently through the invention of grates and furnaces adapted to the use of small sizes of anthracite, stimulated by the higher prices of the prepared sizes, the percentage of waste has been reduced to a minimum. "Buckwheat," "rice," "barley," and even culm are now important steam-raising fuels, particularly in hotels, apartment houses, and large office buildings in the larger cities of the East, where smoke-inhibiting ordinances are in force. In fact, these small sizes are now the only grades of anthracite used to any extent for this purpose, and are the only sizes that will compete with bituminous coal for steam raising in the eastern markets. An object lesson in practical conservation is here furnished and, to the credit of the operators in the anthracite region be it said, it was put into effect a number of years before the agitation over the conservation of natural resources began. Not only are the small sizes produced in the present mining operations sold and utilized, but the unsightly culm banks which blotted the landscape in the anthracite region are fast disappearing as the usable coal is being recovered from them by washeries. The prices for buckwheat at New York Harbor in 1910 ranged from $2.20 to $2.50 per long ton; rice ranged from $1.65 to $2; and barley from $1.35 to $1.50. With 65 per cent of the tidewater price representing the value at the mines, the prices for these sizes f. o. b. cars at mines were, buckwheat, $1.43 to $1.63; rice, $1.07 to $1.30; and barley, 88 cents to 98 cents. The culm used at the mines is valued at 25 to 50 cents a ton.

Of the total production of 75,433,246 long tons in 1910, 4,184,629 tons were recovered from the old culm banks by washeries, and 91,833 tons were recovered by dredges from the bed of Susquehanna River. The total output from the mines was 71,156,784 long tons. In 1909 the mine production was 67;945,137 long tons.

The anthracite-producing industry in 1910 was without any marked features. The operators and miners had in 1909 renewed by mutual agreement for a third term of three years the awards of the Anthracite Commission that settled the great strike of 1902, and although there were a few cases of temporary shutdowns because of labor difficulties, there was only one instance in which the idleness extended over 12 days, and most of the troubles lasted from one day to one week. The board of conciliation created by the Anthracite Commission, consisting of six members, three representing the operators and three representing the miners, has done exemplary service in bringing the employers and employees into harmonious relations and has demonstrated the wisdom and practicability of conciliatory methods of settling labor disputes.

The policy adopted several years ago by the operators of allowing discounts from the circular prices for coal purchased in the spring and early summer months continues to work satisfactorily. The discounts allowed on domestic sizes are 50 cents a ton in April, 40 cents a ton in May, 30 cents in June, 20 cents in July, and 10 cents in August, the circular prices being restored in September. The inducement thus offered to make the cellars of consumers the storage places for the winter supplies of fuel has had a notably steadying influence on the trade and gives employment to the miners through the entire year, against rush work in winter and much idleness in summer before the rule became effective. The effect of the discounts on shipments in 1910 is shown in the fact that the shipments in April, May, and June each exceeded those in either January, February, or March. April shipments were larger than in any other month except December, which was exceptionally cold. The effect upon the miners is shown in the figures giving the average number of days worked. From 1897 to 1901, inclusive, the average number of days worked in the anthracite mines ranged from 150 to 196, with a mean average of 165 days. From 1906 to 1910 the average number of working days ranged from 195 to 229, with a mean average of 210. This means in addition to the increase in wages following the strike of 1902, and the further benefits secured to the miners through the sliding scale created at the same time, that the miners by reason of an increase of 27 per cent in their working time are able to further supplement their earnings by that percentage. With these facts in mind one may easily believe the statements frequently made that at no time in the history of the anthracite trade have there existed the prosperity and contentment that have had place in the region during the last eight years.

According to a statement made to the United States Bureau of Mines by Mr. James E. Roderick, chief of the Department of Mines of Pennsylvania, there were 601 fatal and 1,050 nonfatal accidents in the anthracite mines in 1910. This was an increase of 34 in the number of fatal accidents, and of 15 in the number of men injured, as compared with 1909, when 567 men were killed and 1,035 injured. As the production in 1910 amounted to 75,433,246 long tons (equivalent to 83,485,235 short tons), the quantity of coal mined for each life lost was 125,513 long tons (or 140,575 short tons), against 127,644 long tons (142,961 short tons) in 1909. The death rate per thousand employees in 1910 was 3.55 against 3.31 in 1909.

The statistics of anthracite production during the last five years are presented in the following table:

Statistics of anthracite production, 1906–1910.

Year.	Quantity (long tons).	Value.	Average price per ton.	Average number of men employed.	Average number of days worked.
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	72,384,249	149,181,587	2.06	[a] 171,195 [b] 166,801	205
1910	75,433,246	160,275,302	2.12	169,497	229

[a] State mining department figures. [b] U. S. census figures.

It is to be observed in the foregoing table that the average price in 1909 was considerably lower than in 1910 and in either 1907 or 1908. This was due partly to the slack demand following the settlement of the wage scale of April 1, 1909, and partly to the increased consumption of smaller sizes, which, except for the portion recovered from old culm banks, are sold much below the actual cost of production. The demand for these sizes in 1910 was, proportionate to output, in excess of that for the prepared sizes, and prices for pea coal and smaller sizes have shown a tendency to advance. There was also a steadier tone in the market for prepared sizes in 1910 than in 1909. Any fluctuations in the average price are apt to be due to more or fewer sales of certain sizes, not to any variation in the price of those sizes.

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 and 1910 it was reported by the operators as of the same value as similar coal put on the market.

The production, by counties, in 1909 and 1910, with the distribution of the product for consumption, is shown in the table following:

Anthracite production in 1909 and 1910, by counties, in long tons.

County.	Shipped.	Sold to local trade and employees.	Used at mines for steam and heat.	Total.
1909.				
Carbon	1,961,362	77,665	260,872	2,299,899
Columbia	847,685	21,713	118,503	987,901
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	62,697,495	1,966,069	7,720,685	72,384,249
1910.				
Carbon	2,438,321	64,800	299,734	2,802,855
Columbia	728,370	12,837	104,141	845,348
Dauphin	602,948	55,931	132,364	791,243
Lackawanna	17,390,927	453,670	1,721,768	19,566,365
Luzerne	24,886,361	732,449	2,928,993	28,547,803
Northumberland	4,960,463	119,408	633,398	5,713,269
Schuylkill	13,678,396	279,137	1,986,641	15,944,174
Sullivan	518,889	6,898	39,175	564,962
Susquehanna	508,086	9,935	47,373	565,394
River dredges	22,263	69,017	553	91,833
Total	65,735,024	1,804,082	7,894,140	75,433,246

The following table shows the shipments, by months, during the last five years, 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, 1906–1910, in long tons.

Month.	1906	1907	1908	1909	1910
January	5,458,084	5,249,946	5,618,339	5,183,345	5,306,618
February	4,712,099	4,563,720	4,503,756	4,576,004	5,031,784
March	5,797,167	5,235,814	4,766,158	6,332,474	5,174,166
April	488,203	5,916,583	5,987,221	5,891,176	6,224,396
May	3,254,230	5,994,272	6,088,116	5,063,873	5,679,661
June	5,676,018	5,976,906	5,704,852	4,904,858	5,398,123
July	4,981,448	5,669,024	4,541,506	4,020,765	4,202,059
August	5,400,511	5,795,347	4,599,093	4,198,273	4,996,044
September	4,527,886	5,512,717	5,211,047	4,116,120	4,967,516
October	5,384,768	6,108,065	5,977,497	5,579,759	5,622,095
November	5,182,153	5,743,522	5,839,491	6,027,800	6,071,746
December	4,836,028	5,343,477	5,827,938	5,775,438	6,231,578
Total	55,698,595	67,109,393	64,665,014	61,969,885	64,905,786

The greater increase in the consumption of the smaller or unprofitable sizes as compared with the increase in the production of the prepared or profitable sizes, which has been referred to in previous reports, is exhibited again in the statistics for 1910. In 1890 the proportion of the total shipments of anthracite represented by the sizes above pea coal was 76.9 per cent, and 23.1 per cent was made up of pea coal and smaller sizes; in 1900 it was 64.7 and 35.3 per cent, respectively, and in 1910, 58.4 and 41.6 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 the 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 1910 it amounted to 3,296,318 tons, or 5.02 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, 1909, and 1910, 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
1909	36,361,444	61.6	22,632,445	38.4	58,993,889
1910	38,387,111	61.5	24,029,332	38.5	62,416,443

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 1890 the following table is appended:

Shipments of anthracite, according to sizes, 1890–1910, 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	36,437,762	58.1	a 26,250,597	41.9	a 62,688,359
1910	38,415,323	58.5	a 27,297,438	41.5	a 65,712,761

a Exclusive of coal recovered by river dredges.

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, 1890–1910, 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	62,688,359	5.26
1910	3,296,318	65,712,761	5.02

The following table shows the quantities of the different sizes of freshly mined coal and of washery coal shipped in 1910:

Shipments, by sizes, from mines and washeries in 1910, in long tons.

Size.	From mines.	From washeries.
Lump and steamboat	722,767	....
Broken	3,359,075	....
Egg	7,947,100	....
Stove	12,031,886	27
Chestnut	14,326,283	28,185
Pea	7,634,989	215,043
Buckwheat:		
No. 1	8,719,514	745,014
No. 2 and rice	4,891,994	1,259,684
No. 3	2,392,256	1,007,195
Screenings	390,579	41,170
Total	62,416,443	3,296,318

As shown in 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 1910 aggregated nearly 37,700,000 tons of the 62,416,443 tons of mine coal shipped during the year.

In the following tables are presented statements showing the quantity and percentage of each size shipped from each county in 1909 and 1910. The statistics for 1909 published in the report for that year were the first compilation of this character that has been prepared.

Quantity and percentage of each size of anthracite shipped from each county in 1909 and 1910, in long tons.

1909.

County.	Lump and steamboat.		Broken.		Egg.		Stove.	
	Quantity.	Per cent.	Quantity.	Per cent.	Quantity.	Per cent.	Quantity.	Per cent.
Carbon	68,276	9.26	185,346	5.51	217,087	2.86	279,688	2.41
Columbia	32,205	4.37	54,201	1.61	101,064	1.33	139,350	1.20
Dauphin			26,549	.79	42,974	.57	88,934	.77
Lackawanna	72,216	9.79	632,998	18.82	1,917,709	25.29	3,236,736	27.92
Luzerne	197,443	26.78	1,348,921	40.12	3,228,754	42.58	4,826,735	41.62
Northumberland	41,800	5.67	142,177	4.23	468,028	6.17	952,301	8.21
Schuylkill	325,451	44.13	949,345	27.96	1,508,435	19.90	1,921,532	16.57
Sullivan			10,341	.31	52,101	.69	69,386	.60
Susquehanna and Wayne			21,750	.65	46,307	.61	80,500	.70
Total	737,391	100.00	3,362,628	100.00	7,582,459	100.00	11,595,165	100.00

County.	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	2.42	268,792	3.53	281,893	3.03	222,679	3.98
Columbia	177,056	1.35	109,021	1.43	139,057	1.50	77,947	1.39
Dauphin	106,407	.81	70,775	.93	160,773	1.73	126,642	2.27
Lackawanna	3,468,476	26.36	1,921,044	25.20	2,083,363	22.42	1,596,051	28.56
Luzerne	5,707,896	43.37	2,735,081	35.88	3,362,755	36.20	1,730,902	30.97
Northumberland	965,011	7.33	626,139	8.21	858,162	9.24	524,535	9.39
Schuylkill	2,188,928	16.63	1,759,487	23.08	2,315,303	24.92	1,304,829	23.35
Sullivan	101,418	.77	67,095	.88				
Susquehanna and Wayne	126,017	.96	65,907	.86	89,005	.96	5,256	.09
Total	13,160,119	100.00	7,623,341	100.00	9,290,311	100.00	5,588,841	100.00

County.	Buckwheat No. 3 and barley.		Screenings.		Total.	
	Quantity.	Per cent.	Quantity.	Per cent.	Quantity.	Per cent.
Carbon	118,691	3.47			1,961,362	3.13
Columbia	17,784	.52			847,685	1.34
Dauphin	11,327	.33	9,219	2.85	643,600	1.03
Lackawanna	1,456,444	42.52	11,233	3.48	16,396,270	26.16
Luzerne	1,260,957	36.81	36,969	11.45	24,436,413	38.98
Northumberland	41,676	1.22	343	.11	4,620,175	7.37
Schuylkill	481,257	14.05	39,762	12.32	12,785,329	20.40
Sullivan			225,303	69.79	525,644	.84
Susquehanna and Wayne	37,139	1.08			471,881	.75
Total	3,425,275	100.00	322,829	100.00	62,688,359	100.00

Quantity and percentage of each size of anthracite shipped from each county in 1909 and 1910, in long tons—Continued.

1910.

County.	Lump and steamboat.		Broken.		Egg.		Stove.	
	Quantity.	Per cent.	Quantity.	Per cent.	Quantity.	Per cent.	Quantity.	Per cent.
Carbon	38,201	5.29	180,273	5.37	298,015	3.75	340,687	2.83
Columbia	16,599	2.30	24,328	.73	104,979	1.32	103,777	.86
Dauphin			27,463	.82	42,562	.54	95,362	.79
Lackawanna	41,106	5.69	538,418	16.03	1,846,128	23.23	3,548,387	29.49
Luzerne	221,338	30.62	1,520,253	45.26	3,410,093	42.91	4,671,497	38.83
Northumberland	50,904	7.04	160,580	4.79	495,863	6.24	987,841	8.21
Schuylkill	354,619	49.06	884,518	26.33	1,647,590	20.73	2,120,098	17.62
Sullivan			14,518	.41	50,209	.63	64,053	.53
Susquehanna			8,724	.26	51,661	.65	100,211	.84
Total	722,767	100.00	3,359,075	100.00	7,947,100	100.00	12,031,913	100.00

County.	Chestnut.		Pea.		Buckwheat, No. 1.		Buckwheat, No. 2, and rice.	
	Quantity.	Per cent.	Quantity.	Per cent.	Quantity.	Per cent.	Quantity.	Per cent.
Carbon	437,970	3.05	292,216	3.72	392,472	4.15	372,409	6.05
Columbia	182,442	1.27	91,305	1.16	122,362	1.29	75,355	1.23
Dauphin	99,661	.69	62,602	.80	143,702	1.52	121,564	1.98
Lackawanna	3,939,588	27.44	2,121,208	27.02	2,169,377	22.92	1,651,619	26.85
Luzerne	5,960,699	41.53	2,689,939	34.27	3,170,730	33.50	1,816,623	29.53
Northumberland	1,042,018	7.26	647,502	8.25	924,162	9.76	580,156	9.43
Schuylkill	2,457,086	17.12	1,804,709	22.99	2,456,691	25.96	1,524,569	24.78
Sullivan	100,077	.70	67,193	.86				
Susquehanna	134,927	.94	73,358	.93	85,032	.90	9,383	.15
Total	14,354,468	100.00	7,850,032	100.00	9,464,528	100.00	6,151,678	100.00

County.	Buckwheat, No. 3, and barley.		Screenings.		Total.	
	Quantity.	Per cent.	Quantity.	Per cent.	Quantity.	Per cent.
Carbon	86,078	2.53			2,438,321	3.71
Columbia	7,223	.21			728,370	1.11
Dauphin	2,361	.07	7,671	1.78	602,948	.92
Lackawanna	1,518,030	44.66	17,066	3.95	17,390,927	26.46
Luzerne	1,314,123	38.66	111,066	25.73	24,886,361	37.87
Northumberland	71,437	2.10			4,960,463	7.55
Schuylkill	355,409	10.45	73,107	16.93	13,678,396	20.82
Sullivan			222,839	51.61	518,889	.79
Susquehanna	44,790	1.32			508,086	.77
Total	3,399,451	100.00	431,749	100.00	65,712,761	100.00

The following table gives the yearly shipments of anthracite, as reported by the Bureau of Anthracite Coal Statistics, from the earliest date to the close of 1910, 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, 1820–1910, in long tons.

Year.	Schuylkill region.		Lehigh region.		Wyoming region.		Total.
	Quantity.	Percentage.	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
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

Annual shipments from the Schuylkill, Lehigh, and Wyoming regions, 1820–1910, in long tons—Continued.

Year.	Schuylkill region.		Lehigh region.		Wyoming region.		Total.
	Quantity.	Percentage.	Quantity.	Percentage.	Quantity.	Percentage.	Quantity.
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,[illegible]89,437	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,[illegible]78,314	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	4,34[illegible],061	12.55	19,684,929	56.82	34,641,018
1888	10,654,116	27.93	5,639,236	14.7[illegible]	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
1896	13,097,571	30.34	6,490,441	15.03	23,589,473	54.63	43,177,485
1897	12,[illegible]81,061	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	[illegible]5,857,897	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	8,32[illegible],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
1910	17,845,020	27.49	8,627,539	13.29	38,433,227	59.22	64,905,786
Total	557,369,735	31.86	273,483,097	15.63	918,543,554	52.51	1,749,396,386

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 Scranton Pittston Wilkes-Barre Plymouth Kingston	Wyoming.
Eastern middle	Green Mountain Black Creek Hazleton Beaver Meadow Panther Creek	Lehigh.
Southern	East Schuylkill West Schuylkill Lorberry Lykens Valley	Schuylkill.
Western middle	East Mahanoy West Mahanoy Shamokin	Schuylkill.

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 10 so-called initial railroads, as follows:

Philadelphia & Reading Railway.
Lehigh Valley Railroad.
Central Railroad of New Jersey.
Delaware, Lackawanna & Western Railroad.
Delaware & Hudson Co.'s Railroad.
Pennsylvania Railroad.
Erie Railroad.
New York, Ontario & Western Railroad.
Delaware, Susquehanna & Schuylkill Railroad (part of Lehigh Valley system).
New York, Susquehanna & Western Railroad (part of Erie system).

PENNSYLVANIA BITUMINOUS COAL.

Total production in 1910, 150,521,526 short tons; spot value, $153,029,510.

The different districts of the Pennsylvania bituminous coal regions were variously affected during 1910. In the western field, particularly in Allegheny and Washington counties, production was stimulated beyond that of any previous year, because of the strike of miners in Illinois and the Southwestern States. There were also unusually large quantities of coal shipped to the upper Lake markets during the summer. On the contrary in the Connellsville coking district the production was not materially different from that of 1909. A strike of the miners in the Irwin-Greensburg district, which was ordered on April 1, was not officially called off until July, 1911. This district is contained principally in the western part of Westmoreland County, and the production of that county decreased over 2,500,000 tons, which was, however, nearly made up by an increase of 2,230,000 tons in Fayette County. In the Clearfield or central Pennsylvania district conditions were far from satisfactory. The operators in this district were not benefited by the short supply of coal in the Middle Western States, as the mines in Ohio and western Pennsylvania serve as a barrier to the coal from the central part of the State. Complaint is also made that the geographic advantage of the central Pennsylvania district is not recognized by the transportation interests. The output of this district competes in the eastern markets with high-grade coals from Virginia and West Virginia which are also cheaply mined, while the wages paid in the Clearfield district are higher than those paid in any other district with which it has to compete.

The car supply for the entire bituminous regions of Pennsylvania in 1910 was in the main adequate for the requirements, operators reporting the situation better in this respect than for several years past. There was also a plentiful supply of labor, many of the miners from the Illinois and Southwestern fields seeking employment in the Pennsylvania mines.

Summed up, the record of bituminous coal production in Pennsylvania for 1910 shows a total output of 150,521,526 short tons, valued at $153,029,510. In tonnage this exceeds any previous record, beating that of 1907 by nearly 400,000 short tons, though the value of the 1907 output was larger than that of 1910 by over $2,600,000. Compared with 1909, when the quantity mined was 137,966,791 short tons, valued at $130,085,237, the production in 1910 showed an increase of 12,554,735 short tons, or 9.1 per cent, in quantity and of $22,944,273, or 17.64 per cent, in value.

The most important increase in 1910 was in the counties of Washington and Allegheny, which secured the largest benefit from the strike in the western fields. Washington County increased its production by 3,656,498 short tons and Allegheny County gained 2,748,326 tons. The production of Fayette County increased 2,231,004 tons, the output of this one county in 1910 exceeding 31,000,000 tons. The increase in Fayette County, however, was more than offset by a decrease in Westmoreland County of 2,546,916 short tons, the result of the prolonged and apparently unwarranted strike in the Irwin-Greensburg section of the county. The combined production of Fayette and Westmoreland counties was something over 53,500,000 tons, or more than 10 per cent of the total coal production, anthracite and bituminous combined, of the entire United States. In spite of the untoward conditions obtaining in the central part of the State, production increased in most of the more important producing counties and in some cases with advance in value. Cambria County gained 1,084,276 short tons, with an advance from $1.05 to $1.06 in the average price per ton; Clearfield County's production increased 890,588 short tons and the average price declined from 95 cents to 94 cents; Indiana County recorded a gain of 1,273,161 tons, with an advance from 91 cents to 92 cents; Jefferson County increased its production 733,976 tons, and the average price advanced from 82 cents to 90 cents; the average price in Somerset County declined from $1.09 to $1.04, but the production increased 935,344 short tons. Altogether in the 24 counties in the State having more than three producers production increased in 18 and decreased in 6. Except in Westmoreland County, the decreases were not of any significance.

The year 1910 was in the main more satisfactory than either 1908 or 1909, but the prospects at the close of the year were not encouraging. During the later months there was a decided falling off in the steel-consuming industries, and this was so reflected in the coal and coke markets that in the latter part of December some of the mines and ovens were operating only at 50 to 65 per cent of their capacity.

The bituminous coal mines of Pennsylvania gave employment in 1910 to 175,403 men, who made the somewhat unusually high average of 238 days. The majority of the mines are worked 8 hours a day.

In 1910, 834 mines employing a total of 101,208 men worked 8 hours, 272 mines employing 30,270 men worked 9 hours, and 225 mines employing 37,769 men worked 10 hours. Mines not reporting the length of the working day employed 6,156 men. The average production for each man for the year was 858 tons, and the average daily production per man was 3.61 tons. Both of these averages are high and were exceeded by those of only five other States.

Of the total production in 1910, 68,501,041 short tons (45.51 per cent) were mined by machines, of which 5,505 were in use. In 1909 there were 5,616 machines in use and the machine-mined product amounted to 57,504,188 tons, or 41.68 per cent of the total. The 5,505 machines in 1910 included 3,534 punchers, 1,885 chain-breast, and 86 long wall.

According to Mr. James E. Roderick, chief of the Pennsylvania Department of Mines (report received by the Geological Survey through the United States Bureau of Mines), there were 539 men killed and 1,142 injured in the bituminous mines of the State in 1910. The death rate per thousand was 3.07, and there were 279,261 tons of coal mined for each life lost; in 1909 there were 506 men killed and 1,126 injured, the rate of mortality per thousand being 2.72 and the quantity of coal mined for each fatality being 272,661 tons.

The statistics of production, by counties, with the distribution of the product for consumption in 1909 and 1910, are shown in the following table:

Bituminous coal production of Pennsylvania in 1909 and 1910, by counties, in short tons.

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.

Bituminous coal production of Pennsylvania in 1909 and 1910, by counties, short tons—Continued.

1910.

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	17,788,864	745,430	299,566	1,476	18,835,336	$20,359,650	$1.08	228	23,877
Armstrong	3,062,669	136,712	105,534	....	3,30[illegible],915	3,111,518	.94	259	4,370
Beaver	183,253	42,299	2,674	....	228,226	279,483	1.22	283	388
Bedford	500,231	8,683	10,810	197,109	716,833	753,168	1.05	194	1,162
Blair	318,441	1,049	7,533	53,847	380,870	422,625	1.11	245	637
Butler	983,098	12,503	22,208	....	1,017,809	1,067,905	1.05	236	1,467
Cambria	14,481,395	427,320	325,876	1,394,870	16,629,461	17,566,903	1.06	240	23,501
Center	1,266,130	25,688	1,804	....	1,293,622	1,244,732	.96	235	1,829
Clarion	1,121,209	8,230	27,258	....	1,156,697	1,126,569	.97	226	1,713
Clearfield	7,641,725	244,972	204,301	372,912	8,463,910	8,048,056	.94	230	11,521
Clinton	299,578	9,353	2,042	....	310,973	378,898	1.22	239	396
Elk	1,109,056	28,683	23,254	41,330	1,202,323	1,186,650	.99	239	2,017
Fayette	7,479,414	309,082	553,859	22,754,878	31,097,233	31,210,480	1.00	265	24,707
Huntingdon	649,953	7,355	11,918	....	669,226	773,739	1.15	218	1,014
Indiana	8,414,684	45,831	199,935	293,916	8,954,366	8,277,938	.92	242	10,096
Jefferson	4,403,191	76,154	109,780	1,079,758	5,668,883	5,09[illegible]	.90	236	6,391
Lawrence	81,282	5,243	8,577	....	95,102	115,276	1.21	214	459
Mercer	772,998	53,752	41,004	....	867,754	1,012,[illegible]	1.17	226	1,350
Somerset	8,499,755	78,891	198,738	60,298	8,837,682	9,191,[illegible]	1.04	263	9,836
Tioga	987,062	40,309	10,046	....	1,037,417	1,601,995	1.55	230	2,024
Washington	15,198,042	106,607	411,904	922,124	16,638,677	17,567,634	1.06	228	20,7[illegible]4
Westmoreland	13,263,703	449,844	617,694	8,554,163	22,885,404	22,389,051	.98	229	25,035
Other counties[a] and small mines	94,852	121,198	6,037	6,720	228,807	250,354	1.09	198	249
Total	108,600,585	2,985,188	3,202,352	35,733,401	150,521,526	153,029,510	1.02	238	175,403

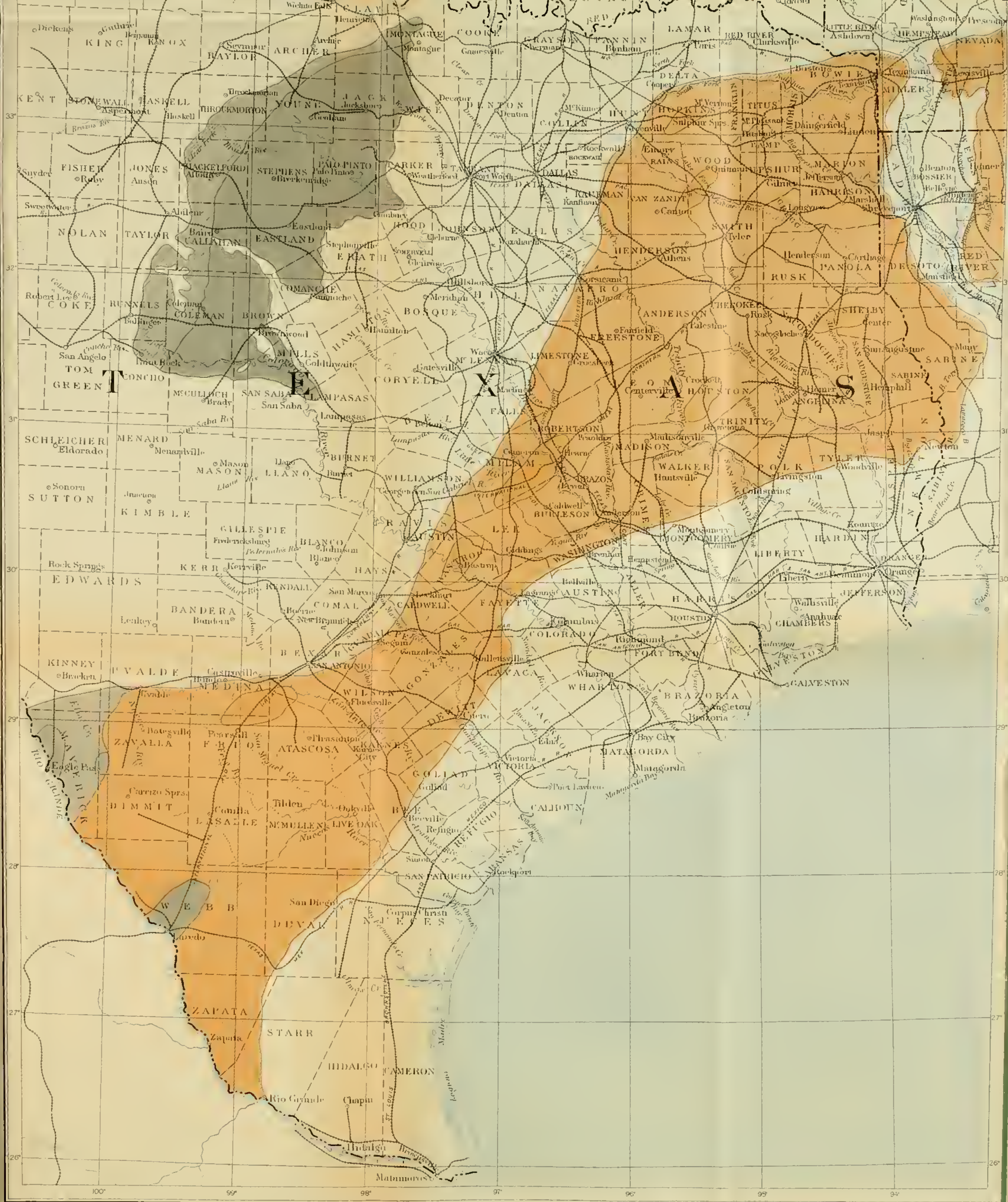
[a] Bradford, Cameron, Greene, and Lycoming.

The statistics of production by counties during the last five years, with increase and decrease in 1910 as compared with 1909, are shown in the following table:

Bituminous coal production of Pennsylvania, 1906–1910, by counties, in short tons.

County.	1906	1907	1908	1909	1910	Increase (+) or decrease (—), 1910.
Allegheny	16,823,027	18,315,736	14,083,843	16,087,010	18,835,336	+ 2,748,326
Armstrong	2,574,758	3,430,002	2,777,486	2,787,508	3,304,915	+ 517,407
Beaver	81,531	109,575	222,711	224,450	228,226	+ 3,776
Bedford	734,855	967,313	511,014	435,129	716,833	+ 281,704
Blair	402,438	493,219	315,167	410,161	380,870	— 29,291
Butler	803,499	902,729	802,462	828,043	1,017,809	+ 189,766
Cambria	12,439,152	16,361,880	14,138,308	15,545,185	16,629,461	+ 1,084,276
Center	895,434	1,256,383	1,086,384	1,239,049	1,293,622	+ 54,573
Clarion	719,548	1,078,367	972,785	941,059	1,156,697	+ 215,638
Clearfield	5,944,745	8,034,711	6,247,534	7,573,322	8,463,910	+ 890,588
Clinton	233,674	322,624	253,958	272,184	310,973	+ 38,789
Elk	944,367	1,427,841	1,147,209	1,150,675	1,202,323	+ 51,648
Fayette	27,044,451	29,260,622	19,474,417	28,866,229	31,097,233	+ 2,231,004
Greene	144,251	158,187	145,644	137,448	77,321	— 60,127
Huntingdon	630,155	721,604	598,094	502,823	669,226	+ 166,403
Indiana	4,657,457	7,635,998	6,843,179	7,681,205	8,954,366	+ 1,273,161
Jefferson	5,160,195	5,964,397	4,853,313	4,934,907	5,668,883	+ 733,976
Lawrence	257,716	220,718	142,639	156,749	95,102	— 61,647
Lycoming	44,425	51,956	34,626	28,016	25,725	— 2,291
Mercer	842,648	955,290	724,158	893,880	867,754	— 26,126
Somerset	6,674,191	7,769,708	7,404,945	7,902,338	8,837,682	+ 935,344
Tioga	826,925	1,146,353	682,099	785,922	1,037,417	+ 251,495
Washington	12,714,405	14,535,727	12,118,007	12,982,179	16,638,677	+ 3,656,498
Westmoreland	27,573,420	28,916,721	21,499,292	25,432,320	22,885,404	— 2,546,916
Small mines	[a]125,939	[b]105,516	[c]100,253	[d]169,000	125,761	— 43,239
Total	129,293,206	150,143,177	117,179,527	137,966,791	150,521,526	+ 12,554,735
Total value	$130,290,651	$155,664,026	$118,816,303	$130,085,237	$153,029,510	+$22,944,273

[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.



COAL AND LIGNITE AREAS OF TEXAS

Scale $\frac{1}{7500000}$

25 0 25 50 75 100 Miles

1911

Areas known to contain workable bituminous coals

Areas that may contain workable bituminous coals

Areas known to contain workable lignite

Areas that may contain workable lignite

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 1910, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1840	464,826	1859	2,400,000	1878	15,120,000	1897	54,417,974
1841	475,000	1860	2,690,786	1879	16,240,000	1898	65,165,133
1842	500,000	1861	3,200,000	1880	18,425,163	1899	74,150,175
1843	650,000	1862	4,000,000	1881	22,400,000	1900	79,842,326
1844	675,000	1863	5,000,000	1882	24,640,000	1901	82,305,946
1845	700,000	1864	5,839,000	1883	26,880,000	1902	98,574,367
1846	760,000	1865	6,350,000	1884	28,000,000	1903	103,117,178
1847	399,840	1866	6,800,000	1885	26,000,000	1904	97,938,287
1848	500,000	1867	7,300,000	1886	27,094,501	1905	118,413,637
1849	750,000	1868	7,500,000	1887	31,516,856	1906	129,293,206
1850	1,000,000	1869	6,750,000	1888	33,796,727	1907	150,143,177
1851	1,200,000	1870	7,798,518	1889	36,174,089	1908	117,179,527
1852	1,400,000	1871	9,040,565	1890	42,302,173	1909	137,966,791
1853	1,500,000	1872	11,695,040	1891	42,788,490	1910	150,521,526
1854	1,650,000	1873	13,098,829	1892	46,694,576		
1855	1,780,000	1874	12,320,000	1893	44,070,724	Total	2,251,737,097
1856	1,850,000	1875	11,760,000	1894	39,912,463		
1857	2,000,000	1876	12,880,000	1895	50,217,228		
1858	2,200,000	1877	14,000,000	1896	49,557,453		

BITUMINOUS COAL FIELDS OF PENNSYLVANIA.

The bituminous coal fields of Pennsylvania (Pl. XI) include an area of about 14,200 square miles in the western part of the State. The coal-bearing rocks lie in the form of a number of canoe-shaped troughs extending northeast and southwest. There are six or more of these troughs, and they lie at successively lower levels in going toward the Ohio River from either the east or the west, the whole tending to form a major shallow trough, whose axis runs roughly from Pittsburgh to Huntington, W. Va. The folds diminish in strength in going westward from the Allegheny front. Around the rim of the major trough occur the outcrops of the lower measures; in the center the lower measures are deeply buried; and the exposed rocks belong to the upper measures.

The coal-bearing rocks all belong to the Pennsylvanian series, and have a total thickness in the southwest corner of the State of about 2,600 feet. The great bulk of the coal mined comes from the Allegheny and the Monongahela formations, formerly known as the "Lower" and the "Upper Productive Coal Measures." Below the Allegheny formation is the Pottsville, containing, in the western part of the State, the Sharon and the Mercer coals, which have been worked only in restricted areas. The Allegheny formation, with a thickness of 250 to 350 feet, contains at least seven coal horizons, all of which yield workable coal locally. They are called, beginning at the bottom, the Brookville, Clarion, Lower Kittanning, Middle Kittanning, Upper Kittanning, Lower Freeport, and Upper Freeport coals. It is now definitely recognized that the coals of these horizons do not occur in continuous beds, and in many cases not in exactly the same horizons; yet it is clear that the corresponding geologic horizons mark times of conditions generally favorable for coal formation, and that no coal of wide extent is found at other levels. As a rule, the coal beds are not characterized by details of section, roof, or floor by which they can be clearly recognized, except over limited parts of the field. No one of them is continuously workable, but the Lower Kittanning and the Upper Freeport coals are widely workable, and the Lower Freeport has a splendid development over several counties in the northeast part of the field. The Brookville or "A" coal is of workable thickness in spots over a large part of the marginal belt of the coal measures, especially in Jefferson, Clearfield, Center, Cambria, and Somerset counties. The Clarion or "A′" coal reaches workable thickness in about the same belt, though the two are seldom of workable thickness in the same section. Both of these coals are apt to be impure when thick. The Lower Kittanning or "B" coal is the most persistent, uniform, and reliable of the Allegheny coals, although it is thinner than the Freeport coals, seldom exceeding a thickness of 4 feet. It is exposed in workable thickness and purity in 11 of the counties. The Middle and the Upper Kittanning horizons, "C" and "C′," contain but little workable coal, though the Upper Kittanning shows cannel coal at a number of points and stands fourth in productivity. The Lower Freeport coal, "D," is finely developed in Clearfield, Jefferson, Indiana, and Cambria counties—in the well-known Moshannon (Clearfield), Reynoldsville-Punxsutawney, and Barnesboro-Patton basins. Over most of the rest of the territory this seam is either worthless or of too low grade for competition in the present market. The Upper Freeport or coal "E" is a variable and complex bed, extending in gross workable thickness over most of its area, although over a considerable part of this territory it is too much broken up and too impure for profitable mining. It appears to be entirely absent in some localities.

As a whole, the Allegheny formation yields about 40 per cent of the total output of bituminous coal in the State.

For about 600 feet above the Upper Freeport bed occurs the Conemaugh formation, or "Lower Barren Measures." It contains six or more coals, which, however, are workable only in very restricted areas, their best development being found in the Berlin Basin in Somerset County.

Just above the Conemaugh formation lies the Pittsburgh coal, the most uniform in quality and thickness, and for a given area the most valuable coal bed in the bituminous field of Pennsylvania. Although not of as high a grade as the best Allegheny coals to the east, and although varying greatly in quality from east to west, on the whole the Pittsburgh coal, on account of its thickness, its regularity, its high grade, and its adaptability for the production of coke and illuminating gas, has long been the most famous bituminous coal bed in America. It is confined to the southwestern part of the State. The bed gives 9 feet of available coal over large areas, and seldom runs under 4 feet. Above the Pittsburgh coal occur the Redstone, Sewickley, Uniontown, and Waynesburg coals, which are of good workable thickness locally, but in the presence of the great Pittsburgh coal are but little mined.

Mr. Campbell places the amount of coal originally in the anthracite fields of Pennsylvania at 21,000,000,000 short tons, and in the bituminous fields at 112,574,000,000 short tons. Under the conditions in which mining in the anthracite region was carried on in former years, it was estimated that for every ton of coal mined and marketed, 1½ tons approximately were either wasted or left in the ground as pillars for the protection of the workings, so that the actual yield of the beds was only about 40 per cent of the contents. This percentage of waste has been materially reduced by modern methods of mining, but it is probable that the exhaustion to the close of 1910 has actually doubled the production, or, say, 4,360,000,000 short tons. This would leave still in the ground approximately 16,640,000,000 tons, which would be capable of producing, at the rate of 1 ton of coal lost for each ton mined, 8,320,000,000, or approximately 99 times the quantity of anthracite produced in 1910. If all of the coal were to be recovered the supply would last 200 years at the rate of production in 1910. The quantity of anthracite which would actually be produced would probably lie somewhere between half the remaining supply and the total.

The total production of bituminous coal in Pennsylvania to the close of 1910 has amounted to 2,251,737,097 short tons, and allowing only 1 ton of coal lost for every 2 tons mined, the exhaustion to the close of 1910 has amounted approximately to 3,400,000,000 tons. There accordingly remains to be mined a little over 109,000,000,000 tons. At the rate of exhaustion in 1910 the bituminous coal supply of Pennsylvania will still last 480 years.

TENNESSEE.

Total production in 1910, 7,121,380 short tons; spot value, $7,925,350.

Compared with 1909, when the output amounted to 6,358,645 short tons, valued at $6,920,564, the production in 1910 showed an increase of 762,735 short tons, or 12 per cent in quantity and of $1,004,786, or 14.52 per cent in value. Tennessee's coal production in 1910 was the largest in the history of the State, and although in some districts the ability to absorb the increased production was somewhat overtaxed and prices suffered accordingly, the record for the State as a whole was a decided improvement over 1909. In both 1909 and 1910, however, prices were much lower than in any of the three preceding years. The highest price attained for Tennessee coal in recent years was recorded in 1907 when the average for the State was $1.25 per short ton. This was an advance from $1.22 in 1906. In 1908 the average price dropped to $1.15 and dropped again to $1.09 in 1909. The returns for 1910 show a slight advance to $1.11. The quantity of coal produced in Tennessee in 1910 exceeded that of 1907 by over 300,000 short tons, but the value of the product in 1907 was greater than that of 1910 by over $550,000.

The coal mines of Tennessee were practically free from labor troubles in 1910, there being but one mine at which a strike occurred, and in this case the mine was crippled but was not closed down. There were 11,930 men employed, and the average number of working days was 225. The average production for each employee was 597 short tons for the year and 2.65 tons for each working day. In 1908, when 11,812 men were employed in the production of 6,199,171 tons, the average per man was 525 tons for the year and 2.51 for each working day. The increase in efficiency was due in part to the larger proportion of the total output mined by machines. The quantity of coal undercut by machines in 1910 was 1,226,672 short tons, or 17.23 per cent of the total, against 1,040,798 tons, or 16.4 per cent of the total, in 1909 and 787,502, or 12.7 per cent of the total in 1908. The increase in machine-mined tonnage in 1910 over 1909 was made in spite of a decrease from 197 to 180 in the number of machines reported. In 1908 there were 122 machines in use.

About two-thirds of the mine employees in Tennessee work 9 hours a day and something less than one-third work 10 hours. Less than 4 per cent of the total number in 1910 worked 8 hours. Information received by the United States Bureau of Mines from George E. Sylvester, chief mine inspector, is that there were 38 men killed and 210 injured in the coal mines of Tennessee in 1910, an increase of 7 over 1909 in the number of fatal accidents and of 13 in the number of injuries. The death rate per thousand in 1910 was 3.19 and the quantity of coal produced for each life lost was 187,405 tons.

The statistics of production, by counties in 1909 and 1910, with the distribution of the production for consumption, are shown in the following table:

Coal production of Tennessee in 1909 and 1910, by counties, in short tons.

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

1910.

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	787,215	7,016	13,983	....	808,214	$848,611	$1.05	210	1,440
Campbell	1,651,770	27,381	26,386	....	1,705,537	2,016,029	1.18	207	3,230
Claiborne	1,473,487	7,462	14,865	....	1,495,814	1,527,018	1.02	246	1,706
Grundy	319,156	1,519	498	33,225	354,398	389,097	1.10	226	548
Hamilton	244,544	8,327	8,151	66,370	327,392	382,527	1.17	143	798
Marion	507,450	6,602	9,315	41,300	564,667	729,971	1.29	277	877
Morgan	362,439	9,324	9,857	100,693	482,313	472,866	.98	244	809
Overton	72,429	422	1,184	....	74,035	77,913	1.05	215	147
Scott	313,471	43,206	1,497	1,200	359,374	380,205	1.06	209	792
Other counties[b]	523,746	19,953	31,629	372,770	948,098	1,098,200	1.16	261	1,583
Small mines	....	1,538	....	....	1,538	2,913	1.90	....	....
Total	6,255,707	132,750	117,365	615,558	7,121,380	7,925,350	1.11	225	11,930

[a] Bledsoe, Cumberland, Fentress, Hamilton, Rhea, Roane, Sequatchie, and White.
[b] Bledsoe, Cumberland, Fentress, Rhea, Roane, Sequatchie, and White.

The statistics of production, by counties, during the last five years, with increase and decrease in 1910 as compared with 1909, are shown in the following table:

Coal production of Tennessee, 1906–1910, by counties, in short tons.

County.	1906	1907	1908	1909	1910	Increase (+) or decrease (−), 1910.
Anderson	763,834	851,943	854,197	822,803	808,214	− 14,589
Campbell	1,282,107	1,400,000	1,584,543	1,631,339	1,705,537	+ 74,198
Claiborne	1,099,747	1,147,900	1,158,166	1,320,290	1,495,814	+ 175,524
Cumberland	64,247	86,362	22,617	67,606	49,982	− 17,624
Grundy	449,367	564,591	572,101	422,898	354,398	− 68,500
Hamilton	316,532	382,044	58,743	217,080	327,392	+ 110,312
Marion	389,525	401,416	392,166	480,067	564,667	+ 84,600
Morgan	615,705	639,207	585,134	469,537	482,313	+ 12,776
Overton	81,603	74,734	46,078	50,864	74,035	+ 23,171
Rhea	264,918	242,421	173,719	104,128	156,296	+ 52,168
Roane	158,421	170,748	162,669	188,016	193,918	+ 5,902
Scott	168,203	197,165	128,437	127,376	359,374	+ 231,998
White	438,602	425,328	326,729	316,510	346,206	+ 29,696
Other counties and small mines	166,464	226,384	133,872	140,131	201,696	+ 61,565
Total	6,259,275	6,810,243	6,199,171	6,358,645	7,121,380	+ 762,735
Total value	$7,667,415	$8,490,334	$7,118,499	$6,920,564	$7,925,350	+$1,004,786

The United States Census of 1840 states that 558 short tons of coal were produced in Tennessee in that year. It is probable that very little was mined in the State prior to that date. By 1860 the production had increased to 165,300 tons, but after that date development was retarded by the Civil War. Since 1860 the production of Tennessee has increased quite regularly, but not so rapidly as that of Alabama. The annual production of the State since 1840 is shown in the following table:

Production of coal in Tennessee from 1840 to 1910, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1840	558	1859	150,000	1878	375,000	1897	2,888,849
1841	600	1860	165,300	1879	450,000	1898	3,022,896
1842	1,000	1861	150,000	1880	495,131	1899	3,330,659
1843	4,500	1862	140,000	1881	840,000	1900	3,509,562
1844	10,000	1863	100,000	1882	850,000	1901	3,633,290
1845	18,000	1864	100,000	1883	1,000,000	1902	4,382,968
1846	25,000	1865	100,000	1884	1,200,000	1903	4,798,004
1847	30,000	1866	100,000	1885	1,440,957	1904	4,782,211
1848	40,000	1867	110,000	1886	1,714,290	1905	5,766,690
1849	52,000	1868	125,000	1887	1,900,000	1906	6,259,275
1850	60,000	1869	130,000	1888	1,967,297	1907	6,810,243
1851	70,000	1870	133,418	1889	1,925,689	1908	6,199,171
1852	75,000	1871	180,000	1890	2,169,585	1909	6,358,645
1853	85,000	1872	224,000	1891	2,413,678	1910	7,121,380
1854	90,000	1873	350,000	1892	2,092,064		
1855	100,000	1874	350,000	1893	1,902,258	Total	103,983,797
1856	115,000	1875	360,000	1894	2,180,879		
1857	125,000	1876	550,000	1895	2,535,644		
1858	135,000	1877	450,000	1896	2,663,106		

THE COAL FIELDS OF TENNESSEE.[1]

About 4,400 square miles of the State are underlain by coal measures, and by far the greater part of this area contains one or more beds of workable coal. The coal measures occupy a belt extending

[1] See map (Pl. I) accompanying description of the coal fields of Alabama.

entirely across the State in a northeast-southwest direction. This belt has a width of 70 miles at the Kentucky line, and is there practically continuous. At the Georgia-Alabama line its width is about 50 miles, and only the highest land is occupied by coal measures, the valleys of Tennessee River and its tributaries being cut in Mississippian ("Lower Carboniferous") formations.

The greater part of the workable coal occurs in three basins—the Wartburg, the Walden, and the Sewanee. The Cumberland Basin of Kentucky extends from the Middlesboro field to the Elk Valley, and contains over 3,000 feet of beds. Bryson Mountain, Claiborne County, is reported to contain 95 feet of coal, including 13 beds of workable thickness, 7 of them, 4 to 6½ feet thick, having been worked. This field is now developing along the line of the Louisville & Nashville Railroad.

The Wartburg Basin lies north of Emory River, embracing portions of Scott, Anderson, and Morgan counties. It is continuous northward with the Jellico Basin, which lies partly in Tennessee and partly in Kentucky. The central portion of the Wartburg Basin is a deeply dissected plateau, and its coal is but slightly developed. Three beds are at present worked, and these only about the margins. The highest of these is in the Scott shale; the next lower is in the Wartburg sandstone; and the lowest is in the underlying Briceville shale. The latter coal bed averages about 4 feet in thickness on the eastern margin of the basin, decreasing to 3 feet at its western edge. There are, in addition to these two, numerous undeveloped beds, several of which are known to be of workable thickness.

The Walden Basin extends southwestward from Emory River to the Georgia line. It is a narrow, unsymmetrical syncline, the beds having a steep dip on the eastern and a gentle dip on the western margins. The Walden Basin contains seven or more workable coal beds, the most important of which lies at or near the horizon of the Sewanee. The development has thus far been confined chiefly to the eastern margin, where streams flowing from the Walden Plateau have cut narrow gorges through the sharply upturned strata, giving access to the lowest part of the syncline.

The Sewanee Basin is also long and narrow and extends parallel with the Walden Basin, being separated from the latter by the Sequatchie Valley. The strata are practically horizontal, except along the margin of the Sequatchie Valley, where they are sharply upturned. This basin contains several coal beds, the most important of which is the Sewanee, which is exceptional for its uniformity of character over a very large area. It averages about 4 feet in thickness. The principal development has been along the western margin of the Sequatchie Valley and in the outliers of the coal bed occupying the summit of the Cumberland Plateau. By far the larger part of the basin is entirely undeveloped.

Walden and Lookout are not recognized in Wartburg Basin, where the formations are: Scott, Wartburg, Briceville, Lee. The relations of Walden as to these formations is undetermined.

The workable coal in the Walden and Sewanee basins described above is chiefly in the Walden sandstone, above the Lookout sandstone. Locally, one or more coal beds in the Lookout sandstone attain workable thickness and the product is highly esteemed as domestic fuel. These lower beds are developed chiefly at Dayton, Graysville, Bonair, and in the vicinity of South Pittsburg.

The total production of Tennessee to the close of 1910 amounted to 103,983,797 tons, representing an exhaustion of 156,000,000 short tons. According to the estimate by Marius R. Campbell, the bituminous coal fields of Tennessee cover an area of 4,400 square miles, the original content of which when mining began was 25,665,000,000 short tons, of which the exhaustion to the close of 1910 represented 0.6 of 1 per cent of the total estimated supply. The coal still left in the ground is about 3,600 times the production in 1910, or 2,400 times the exhaustion represented by that production.

TEXAS.

The total production in 1910 was 1,892,176 short tons; spot value, $3,160,965.

The total production of coal and lignite in Texas increased from 1,824,440 short tons, valued at $3,141,945, in 1909, to 1,892,176 tons, valued at $3,160,965, in 1910, a gain of 67,736 short tons, or 3.71 per cent, in quantity and of $19,020, or 0.6 of 1 per cent, in value. The average price per ton for the State declined from $1.72 to $1.67. The relatively smaller increase in value and the apparent decline in prices are not, however, indicative of an actual falling off in values. The fact is that there was in reality a general advance in prices, and the seeming inconsistency was due to an increase in the production of the cheaper lignite and a decrease in the production of the higher-priced bituminous output. Both grades showed advances in price, the average for lignite being 87 cents per ton in 1910 against 85 cents in 1909, and that of the bituminous coal $2.37 against $2.28. The influence of the strike in the Southwestern States extended into the bituminous coal fields of northern Texas, and the production for the State decreased from 1,112,228 short tons, valued at $2,539,064, in 1909, to 1,010,944 tons, valued at $2,397,858, in 1910. Lignite production, stimulated by the scarcity of coal caused by the strike, increased from 712,212 tons, valued at $602,881, to 881,232 tons, valued at $763,107. The decrease in the production of bituminous coal was 101,284 tons; the increase in lignite production was 169,020 tons. One county, Van Zandt, was added to the lignite-producing localities in 1910; otherwise the counties producing both bituminous coal and lignite were the same in 1910 as in 1909.

The coal and lignite mines of Texas gave employment in 1910 to a total of 4,197 men for an average of 234 days. The lignite mines employed 1,131 men for an average of 210 days, and the bituminous mines employed 3,066 men for an average of 242 days, the working time in the bituminous mines, notwithstanding the time lost by the strike, exceeding that made in the lignite districts. The strike in the bituminous mines of Texas lasted from April 1 to June 1, and involved a total of 1,776 men, or 58 per cent of all the employees in the bituminous mines.

The average production per man was 330 tons for the year and 1.36 tons per day in the bituminous mines, and 779 tons for the year and 3.7 tons for each working day in the lignite mines. The general averages for all mines were 451 tons and 1.93 tons, respectively.

The Olmos Coal Co., at Eagle Pass, and the Cannel Coal Co., at Laredo, have installed washeries for improving the quality of their output. In 1910 the coal passing through the washeries amounted to 21,296 short tons, yielding 15,339 tons of cleaned coal and 5,957 tons of refuse.

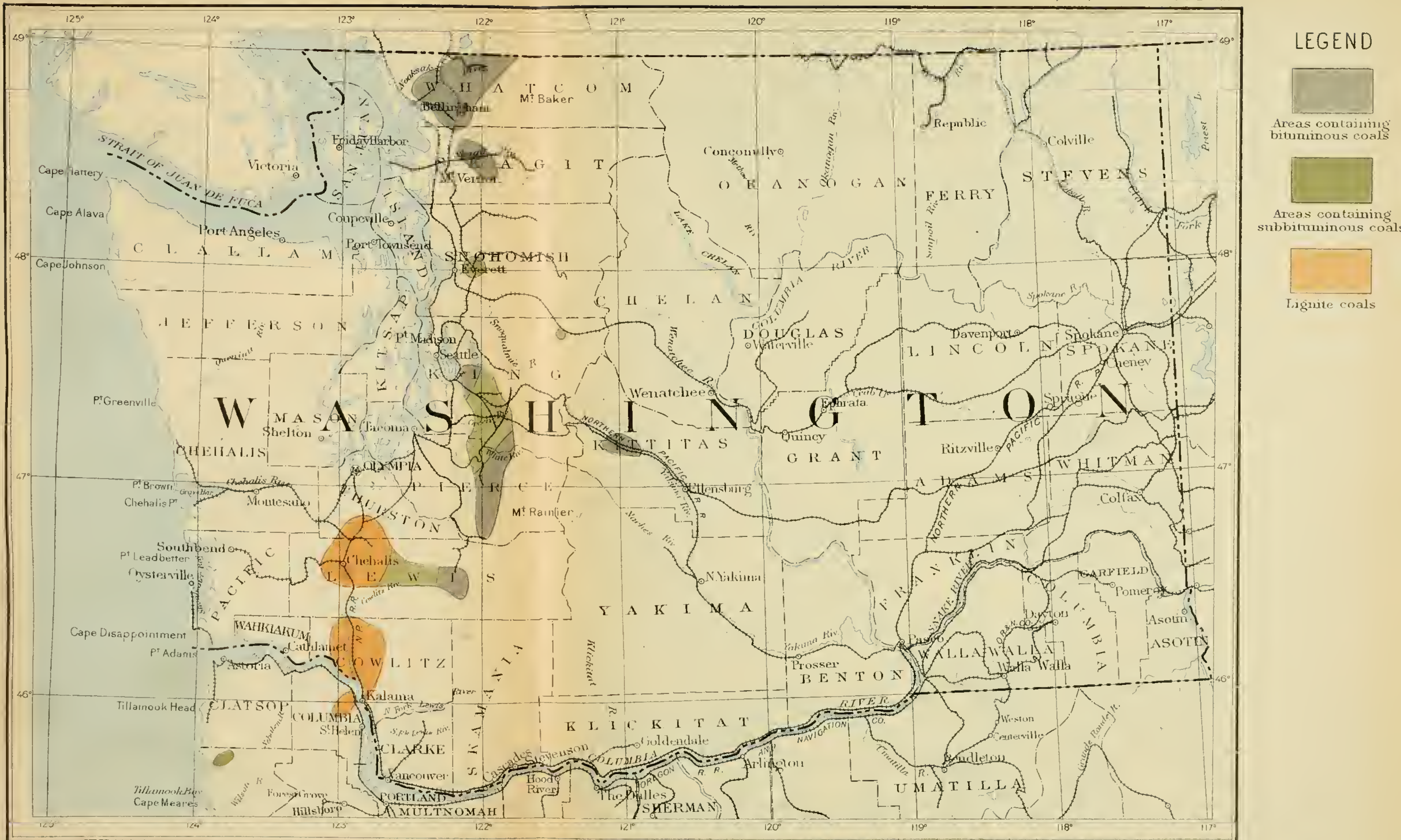
The statistics of production, by counties, in 1909 and 1910, with the distribution of the product for consumption, are shown in the following table. Owing to the fact that there are only one or two mines in each county, the production of the bituminous-producing and of the lignite-producing counties, respectively, is combined.

Coal production of Texas in 1909 and 1910, 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.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
1909.								
Bituminous: Erath, Maverick, Palo Pinto, Webb, Wise, Young	1,070,833	5,036	36,359	1,112,228	$2,539,064	$2.28	....	....
Lignite: Bastrop, Hopkins, Houston, Lee, Leon, Medina, Milam, Robertson, Titus, Wood	699,268	1,326	11,618	712,212	602,881	.85	....	....
Total	1,770,101	6,362	47,977	1,824,440	3,141,945	1.72	....	4,196
1910.								
Bituminous: Erath, Maverick, Palo Pinto, Webb, Wise, Young	978,498	18,471	13,975	1,010,944	$2,397,858	$2.37	242	3,066
Lignite: Bastrop, Hopkins, Houston, Lee, Leon, Medina, Milam, Robertson, Titus, Van Zandt, Wood	864,858	2,231	14,143	881,232	763,107	.87	210	1,131
Total	1,843,356	20,702	28,118	1,892,176	3,160,965	1.67	234	4,197

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 1910 is shown in the following table:

nay contain
le lignite



COAL FIELDS OF WASHINGTON

Scale $\frac{1}{2500000}$

25 0 25 50 75 100 Miles

1911

Coal production of Texas from 1884 to 1910, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1884	125,000	1892	245,690	1900	968,373	1908	1,895,377
1885	100,000	1893	302,206	1901	1,107,953	1909	1,824,440
1886	100,000	1894	420,848	1902	901,912	1910	1,892,176
1887	75,000	1895	484,959	1903	926,759		
1888	90,000	1896	544,015	1904	1,195,944	Total.	20,056,941
1889	128,216	1897	639,341	1905	1,200,684		
1890	184,440	1898	686,734	1906	1,312,873		
1891	172,100	1899	883,832	1907	1,648,069		

THE COAL FIELDS OF TEXAS.

The coals of Texas (Pl. XII) occur in three of the geologic systems—the Tertiary, the Cretaceous, and the Carboniferous. In the north-central portion of the State are found the bituminous coals, in what is known as the Southwestern field. It is about 250 miles in length, with an average width of about 45 miles, and contains approximately 11,000 square miles. The known coal-bearing strata are, however, much more limited, being confined to the central part of the entire field. The principal mining operations are in Wise, Palo Pinto, Erath, and McCullough counties. Small quantities have been mined in Eastland, Coleman, and Bowie counties, but no production was reported from these counties in 1906 or 1907. The coals of the Cretaceous occur in the southern portion of the State, and mining operations are carried on at Eagle Pass, in Maverick County. Lignite beds of Tertiary age extend entirely across the State from the eastern boundary at Sabine River in a southwesterly direction to the Rio Grande. In the southwestern extremity, near Laredo, in Webb County, the lignite is changed into a higher grade of coal and the Webb County production is classed as bituminous. Lignite mining operations have been carried on in Anderson, Bastrop, Fayette, Hopkins, Houston, Leon, Medina, Milam, Raines, Robertson, Shelby, Van Zandt, and Wood counties, the principal operations being in Medina, Milam, and Wood. During the last few years, or since the discoveries of oil at Beaumont, the lignite-producing industry has suffered greatly from the use of fuel oil, with which it comes into direct competition. Decided advances in the price of fuel oil in 1907, however, reacted favorably upon the demand for and production of lignite, resulting in the largest output and the highest prices ever recorded.

The Bureau of Economic Geology and Technology of the University of Texas, Dr. Wm. B. Phillips, director, has recently made proximate and ultimate analyses of some of the Texas bituminous coals. These are reproduced below. The samples for analysis were not collected in the mines by Dr. Phillips or his assistants, but were sent by the operators to the bureau in tin buckets having closely fitting lids. The calorific determinations were not made in calorimeters but were calculated from the proximate and the ultimate analyses by Goutal and Dulong formulæ. The analyses were made by Mr. S. H. Worrell. The differences shown in the washed and unwashed coal sent in by the Olmos Coal Co. are of special interest.

Composition of Texas coals, by company samples.[a]

[S. H. Worrell, analyst.]

Name.	Moisture.	Proximate analysis, dry.			Ultimate analysis, dry.					B.T.U., dry.
		Volume.	Fixed carbon.	Ash.	Carbon.	Hydrogen.	Oxygen.	Nitrogen.	Sulphur.	
Belknap Coal Co	11.00	38.45	42.68	18.87	58.25	4.17	12.35	2.12	4.24	10,213
Bridgeport Coal Co	9.40	38.30	46.94	14.76	65.42	4.40	9.21	2.80	3.41	11,196
Cannel Coal Co	2.30	54.00	37.97	8.03	71.04	5.65	10.03	3.00	2.25	12,604
International Coal Co	4.85	40.25	48.65	11.10	67.38	4.83	13.08	1.47	2.14	11,695
Olmos Coal Co	6.50	33.70	39.96	26.34	55.44	4.14	9.56	2.52	2.00	9,636
Rio Grande Coal Co	2.80	50.45	38.10	11.45	66.06	5.72	12.18	2.50	2.09	11,740
Santo Mining & Developing Co	3.50	39.50	50.99	9.51	70.91	4.85	9.29	3.34	2.10	12,410
Strawn Coal Mining Co	2.90	39.60	49.56	10.84	70.00	5.15	8.14	2.70	3.17	12,265
Texas & Pacific Coal Co	2.70	41.95	50.08	7.97	71.78	5.35	10.75	2.17	1.98	12,526
Wise County Coal Co	9.20	37.40	41.37	15.23	63.80	4.67	11.40	2.90	2.00	11,269
International Coal Co.:										
Special	8.20	39.20	57.73	3.07	74.74	5.08	13.67	1.64	1.80	12,527
Olmos Coal Co.:										
Washed egg	5.40	38.00	44.49	17.51	64.12	4.92	10.41	1.74	1.30	11,545
Washed nut	5.30	37.38	40.49	21.93	60.01	4.63	9.93	1.80	1.70	10,807
Washed pea	5.70	35.50	30.16	25.34	57.20	4.40	7.96	3.30	1.80	10,412

[a] Belknap Coal Co., Newcastle, Young County; Bridgeport Coal Co., Bridgeport, Wise County; Cannel Coal Co., Laredo, Webb County; International Coal Co., Eagle Pass, Maverick County; Olmos Coal Co., Eagle Pass, Maverick County; Rio Grande Coal Co., Laredo, Webb County; Santo Mining & Developing Co., Weatherford, Parker County; Strawn Coal Mining Co., Strawn, Palo Pinto County; Texas & Pacific Coal Co., Thurber, Erath County; Wise County Coal Co., Bridgeport, Wise County. The Mount Marion Coal Mining Co., Strawn, is practically the same as the Strawn Coal Mining Co., so no separate analysis is given for it.

The International Coal Co., Eagle Pass, submitted a sample of a special coal which it is putting on the market, and the Olmos Coal Co. furnished samples of its washed egg, nut, and pea coal. Analyses of these are shown in the table.

Mr. Campbell's estimates of the coal areas of Texas place the bituminous fields as known to contain workable coal at 8,200 square miles, with 5,300 square miles of area not so well known, but which may contain workable coal. The known lignite areas cover 2,000 square miles, while there are 53,000 square miles, extending from Sabine and Red rivers on the east and north to the Rio Grande on the southwest, which may contain workable beds of lignite. The estimated original supply of bituminous coal in Texas is placed at 8,000,000,000 short tons, and of lignite at 23,000,000,000 tons, making a total of 31,000,000,000 tons as the original supply. From this there had been produced to the close of 1910 a total of 20,056,941 short tons, which represents an exhaustion of approximately 30,000,000 tons, the exhaustion representing 0.1 of 1 per cent of the original supply. The supply left in the ground at the close of 1910 would be equal to 19,000 times the production of that year.

UTAH.

Total production in 1910, 2,517,809 short tons; spot value, $4,224,556.

Compared with 1909, when the coal production of Utah amounted to 2,266,899 short tons, valued at $3,751,810, the output in 1910 showed an increase of 250,910 short tons, or 11.07 per cent, in quantity and of $472,746, or 12.6 per cent, in value. Utah's production in 1910 was affected only indirectly, if at all, by the strikes in the Middle West, that is, by the demand created on the mines of Colorado and

New Mexico which possibly reduced the competition of coals from those States in markets to the west and southwest, reached jointly by them, and the coals from Utah mines. Mr. J. E. Pettit, State mine inspector, whose report for 1910 shows a production differing from that reported to the United States Geological Survey by only 8,000 tons, considers the increased production of Utah an indication of normal growth that may be expected to continue as the country develops in population and industrial enterprises.

The year was one of general prosperity to both operators and miners. Production increased, prices advanced, and although there were no strikes for higher wages or changed conditions, some of the coal-mining companies voluntarily gave an advance of 5 per cent in the wages of their employees. During August and September when the crops were being moved a shortage in car supply was experienced, but as a general thing throughout the year transportation facilities were adequate.

The number of men employed in the coal mines of Utah in 1910 was 3,053, and that they were kept steadily employed is shown by the fact that each man averaged 260 working days. The average quantity of coal mined by each man employed was 824.7 tons for the year, and 3.17 tons for each working day. In 1908 when 2,664 men were employed for an average of 227 days in the production of 1,846,792 tons, the average output by each employee was 693.3 tons for the year and 3.05 tons for each working day.

The statistics of production, by counties, in 1909 and 1910, with the distribution of the product for consumption, are shown in the following table:

Coal production of Utah in 1909 and 1910, 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.
1909.									
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
1910.									
Carbon	1,954,389	8,692	80,863	267,805	2,311,749	$3,882,205	$1.68	274	2,549
Emery	34,043	3,414	3,200		40,657	80,566	1.98	149	229
Summit	141,020	3,301	10,282		154,603	235,881	1.53	222	260
Uinta		8,590			8,590	21,675	2.52	226	15
Small mines		2,210			2,210	4,229	1.92		
Total	2,129,452	26,207	94,345	267,805	2,517,809	4,224,556	1.68	260	3,053

The production by counties during the last five years, with increase and decrease in 1910 as compared with 1909, has been as follows:

Coal production of Utah, 1906–1910, by counties, in short tons.

County.	1906	1907	1908	1909	1910	Increase (+) or decrease (−), 1910.
Carbon	1,693,081	1,836,439	1,719,835	2,125,789	2,311,749	+ 185,960
Emery	4,954	5,052	3,725	1,690	40,657	+ 38,967
Morgan, Sanpete	6,269	3,736	4,500	2,000	....	− 2,000
Summit, Uinta	67,043	102,025	116,534	134,838	163,193	+ 28,355
Small mines	1,204	355	2,198	2,582	2,210	− 372
Total	1,772,551	1,947,607	1,846,792	2,266,899	2,517,809	+ 250,910
Total value	$2,408,381	$2,959,769	$3,119,338	$3,751,810	$4,224,556	+$472,746

The areas in Utah known to contain workable beds of coal aggregate 13,130 square miles, and there are 2,000 square miles less known, but which may contain workable coals. The estimated original coal content of these fields, according to Mr. M. R. Campbell, is placed at 196,458,000,000 short tons. The production of the State since mining began, about 1870, has amounted to 25,468,682 short tons, of which 2,517,809 short tons, or nearly 10 per cent, were mined in 1910. On the basis that for every 2 tons mined 1 ton of coal is lost, the exhaustion of the Utah fields to the close of 1910 is approximately 38,000,000 short tons, or .02 of 1 per cent of the estimated original supply.

Annual production of coal in Utah, 1870–1910, 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	1910	2,517,809
1878	67,200	1889	236,651	1900	1,147,027		
1879	50,000	1890	318,159	1901	1,322,614	Total	25,468,682
1880	14,748	1891	371,045	1902	1,574,521		

THE COAL FIELDS OF UTAH.[1]

The coal fields of Utah are important and widely distributed. The largest and commercially most important coal region in the State is the great Uinta Basin, which lies parallel with and along the southern side of the Uinta Mountains and extends to the southeast as far as Crested Butte, Gunnison County, Colo. This is a great basin of coal-bearing rocks which are exposed in the Book Cliffs along the southern rim and, in places, along the northern rim at the foot of the mountains. The coal-bearing rocks of this basin extend southward

[1] See map (Pl. III) accompanying description of Colorado coal fields.

from its western end from the Wasatch Plateau to a little south of the thirty-ninth parallel of latitude, where they are concealed by lava which flowed from centers of eruption farther to the south. In the central part of the Uinta Basin the coal beds are so deeply covered by Tertiary formations that it is doubtful if they can ever be mined, but along the margins they are easily accessible.

The coal fields may be grouped geographically as follows: The Book Cliffs, Tabby Mountain, Wasatch Plateau, Weber River, southern Utah, and small scattered fields. The Book Cliffs field, including its southern extension, the Wasatch Plateau, is the largest and most important in the State. The coal-bearing rocks of this field outcrop along the Book Cliffs of western Colorado and eastern Utah. There are several beds of coal in this field, varying from 3 to 20 feet in thickness, which occur in the lower part of the Mesaverde formation, of Upper Cretaceous age. The low land at the base of the Book Cliffs is traversed by the Rio Grande Western Railroad, and all of the large mines in the State are situated in this field. The most important of these mines are those at Sunnyside, Castlegate, Winterquarters, and Clear Creek, which produce 95 per cent of the coal output of the State. The coal is a middle-grade bituminous and produces a good quality of coke. The Tabby Mountain field lies on the northern rim of the Uinta Basin northeast of Strawberry Valley. At present it has no railroad connection; so it is little known and without development. It contains at least twenty coal beds. The Weber River field, in the northern part of the State, has an area of only a few square miles, but on account of its railroad connection and mining activity it is next in importance to the Book Cliffs field already described. Two beds of coal, varying from 7 to 14 feet in thickness, are mined at Coalville. Considerable difficulty has been experienced on account of excessive water and extensive fracturing of the rocks. The coal of this field is of Colorado age (Upper Cretaceous).

One of the large fields of the State is the southern Utah field, which extends for many miles in the Colob Plateau and its eastern extension in Iron, Washington, Kane, and Garfield counties as far as Colorado River. The coal is of Colorado age and varies in thickness from less than 1 foot to more than 10 feet. It has been opened at only a few places, in the towns of Cedar River, Kanarra, Upper Kanab, and Escalante. So far as known, the coal is chiefly low-grade bituminous, but locally coal of better quality has been found. A fair grade of cannel coal occurs in the North Fork of Virgin River in the northwestern corner of Kane County, and a small area of semianthracite coal has long been known a few miles north of the town of New Harmony, in Iron County. It is probable that the western part of this field will soon be tapped by a branch line from the San Pedro, Los Angeles & Salt Lake Railroad.

VIRGINIA.

Total production in 1910, 6,507,997 short tons; spot value, $5,877,486.

Virginia established two new records in the statistics of her coal production in 1910—first, in the quantity of coal produced (6,507,997 short tons), and, second, in the amount and percentage of increase over the preceding year. The production in 1909 of 4,752,217 short tons had exceeded all previous records, but this was beaten in 1910 by the unprecedented increase of 1,755,780 tons, or nearly 37 per cent. The value increased $1,626,430, or 38.3 per cent, from $4,251,056 to $5,877,486. Although little if any of the Virginia product was shipped west to make up the deficiency caused by the prolonged strike in the mines of the Mississippi Valley States, the shortage in those States was the indirect cause of the remarkable increase in Virginia's tonnage. The strike in the Middle West created, naturally, an unusual demand upon the coal mines of West Virginia and a large part of the production of that State customarily sent to the seaboard was diverted to the more profitable markets in the West. This, in turn, gave an opportunity for a larger outlet to the seaboard for Virginia coals, an opportunity of which the Virginia operators were not slow to take advantage. The largest increase was made by Wise County, whose production rose from 2,841,448 short tons in 1909 to 3,730,992 tons in 1910, an increase of 889,544 tons, or 31.3 per cent. More than half of the total increase in 1910 was from Wise County. Tazewell and Lee counties, both of which showed decreased production in 1909, made marked gains in 1910, Tazewell County increasing its output from 975,665 short tons to 1,187,146 tons, and Lee County from 449,144 tons to 797,096 tons. The results of the developments in Russell County referred to in the report for 1909, in which year the production increased more than 100 per cent, were exhibited in an output approaching three-quarters of a million tons in 1910. Even the older properties in the Richmond Basin contributed something to the general increase. As stated in the 1909 report, the rehabilitation and redevelopment of the mines at Gayton, in Henrico County, has been undertaken by a New York corporation and in 1910 the mines were again in operation.

Virginia stands well up among the States in the quantity of coal produced for each man employed. In 1910 the number of men employed was 7,264, who worked an average of 241 days. The average production per man was 896 tons for the year, and 3.72 tons for each day. Both of these averages are better than those shown in the majority of the coal-producing States. Most of the miners in the State work 10 hours a day. Of the 7,264 men employed in 1910, 5,710 worked 10 hours and 1,021 worked 9 hours. Only 1 mine was reported as working 8 hours. Mines employing a total of 344 men did not report the number of hours to the working day.

A further notable development in the coal-mining operations of Virginia, as exhibited by the returns for 1910, was in the number of mining machines employed and in the quantity of machine-mined coal. In 1909 there were 107 machines used in the production of 1,323,111 short tons of coal; in 1910 the number of machines increased to 142, and the quantity of machine-mined coal to 2,290,435 tons. The reopened mines at Gayton have been equipped with mining machines, and a washery has also been installed. This is the only coal washery in Virginia.

The statistics of production, by counties, in 1909 and 1910, with the distribution of the product for consumption, are shown in the following table:

Coal production of Virginia in 1909 and 1910, by counties, in short tons.

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.
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

1910.

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.
Lee	643,871	4,448	8,202	140,575	797,096	$768,990	$0.90	254	946
Tazewell	847,578	30,588	46,312	262,668	1,187,146	1,169,981	.99	196	1,191
Wise	1,815,392	40,116	70,017	1,805,467	3,730,992	3,274,809	.88	259	4,449
Other counties[b] and small mines	756,541	13,132	23,090	....	792,763	663,706	.84	180	678
Total	4,063,382	88,284	147,621	2,208,710	6,507,997	5,877,486	.90	241	7,264

[a] Montgomery, Pulaski, and Russell. [b] Henrico, Montgomery, Pulaski, and Russell.

The statistics of production, by counties, for the last five years, with increases and decreases in 1910 as compared with 1909, are shown in the following table:

Coal production of Virginia, 1906–1910, by counties, in short tons.

County.	1906	1907	1908	1909	1910	Increase (+) or decrease (−), 1910.
Tazewell	910,638	1,116,534	980,014	975,665	1,187,146	+ 211,481
Wise	3,041,225	3,145,846	2,558,874	2,841,448	3,730,992	+ 889,544
Pulaski	[a] 302,896	[a] 448,515	[a] 719,954	[a] 931,276	[b] 1,587,162	+ 655,886
Small mines	120	....	200	3,828	2,697	− 1,131
Total	4,254,879	4,710,895	4,259,042	4,752,217	6,507,997	+ 1,755,780
Total value	$4,183,991	$4,807,533	$3,868,524	$4,251,056	$5,877,486	+$1,626,430

[a] Includes Lee, Montgomery, and Russell counties.
[b] Includes Henrico, Lee, Montgomery, and Russell counties.

The annual production of Virginia from 1822 to the close of 1910 is shown in the following table:

Production of coal in Virginia from 1822 to 1910, 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	1910	6,507,997
1842	373,640	1865	40,000	1888	1,073,000		
1843	370,000	1866	40,000	1889	865,786	Total	72,748,408
1844	365,000	1867	50,000	1890	784,011		

a West Virginia separated from Virginia.

THE COAL FIELDS OF VIRGINIA.[1]

To Virginia belongs the distinction of having produced the first bituminous coal mined in the United States. This initial output, however, was not from that portion of the State which now gives Virginia some prominence as a producer of coal, but was obtained from what is generally known as the Richmond Basin, a small area of Triassic age in the southeastern part of the State, near the city of Richmond. The basin is on the eastern margin of the Piedmont Plateau, 13 miles above tide on the James River, and is included within the counties of Goochland, Henrico, Powhatan, and Chesterfield.

The occurrence of coal in this locality was known as early as 1700, though mining did not begin until the latter part of the century. In 1789 shipments were made to some of the Northern States. In 1822, according to Mr. R. C. Taylor, in his "Statistics of Coal," the production amounted to 54,000 short tons. For nearly a century the Richmond Basin maintained some prominence as a coal producer, but when, in 1882, the Pocahontas district was opened up, followed shortly afterwards by the development of the New River field in West Virginia, the mines in the Richmond Basin were put at a disadvantage and operations were practically suspended. During the last two years, through the efforts of the Old Dominion Development Co., the old mines at Gayton, in Henrico County, have been reopened with modern mechanical equipment, including a coal washery, and mining operations were resumed in 1910.

The mining of coal in southwestern Virginia, whence the present production chiefly comes, began with the completion of the New River division of the Norfolk & Western Railway in 1883, in which year the first carload of Pocahontas coal was shipped to Norfolk and dis-

[1] See map (Pl. XIV) accompanying description of West Virginia coal fields.

tributed among the poor. During the next 10 years nearly the entire production of the State was obtained from this locality in Tazewell County, which forms a part of the famous Pocahontas-Flat Top coal field. Ten years from the opening of this district, or in 1892, the extension of the Clinch Valley branch of the Norfolk & Western Railway made accessible rich coal fields in Wise County, the first production in that county having been reported in 1893, when it amounted to 126,216 tons, while that of Tazewell County was 653,374 tons. In 1897 the Wise County production exceeded that of Tazewell County, and since that date Wise County has rapidly become the principal coal-producing county of the State, having in 1910 had nearly three times the output of Tazewell County. The year 1907, practically 15 years from the opening of the Wise County field, and 25 years from the development of the Pocahontas district, marked the beginning of coal mining in another county of Virginia which promises to show a development rivaling the rapid growth of Wise County. The development of the coal resources of Lee County was begun in 1905 in the area known as the "Pocket" district, a short description of which was given in a previous report.[1] This district is chiefly contained in what is known as Black Mountain, a portion of the Cumberland Range. No less than 12 separate beds of workable thickness have been located, and several mining operations are in progress, as shown by the production in 1910. Most of the coal is of high-grade steam and coking quality. In addition, a large amount of development work has been done in Dickenson, Russell, and Buchanan counties, which have been made accessible by the construction of the Carolina, Clinchfield & Ohio Railway, from Dante, Va., to Spartanburg, S. C. A production of 5,000 tons daily is already reported from the mines at Dante and on Dumps Creek, the output being distributed chiefly in the Carolinas. (For a brief description of the coals in Dickenson County see Bull. U. S. Geological Survey No. 348.) The Lee County properties have been made available through the completion of the Virginia & Southwestern Railway, making connection with the Louisville & Nashville Railroad at Appalachia and Pennington Gap and with the Southern Railway and the Norfolk & Western Railway at Bristol. The Virginia & Southwestern has passed into the control of the Southern Railway.

Although the coal fields of southwestern Virginia[2] are of comparatively limited extent, the high quality of the coal and the number and thickness of the beds give promise of a considerably increased production within the next few years.

Two small basins, containing coals of Pocono (basal Mississippian) age, lie to the southeast of the main Allegheny coal field in the State—one in Frederick County, at the north, and the other in Pulaski and Montgomery counties, at the south. In both the coal is semianthracite, with about 84 to 86 per cent of fixed carbon in pure coal, but the only developments on a practical scale have been made in the Pulaski-Montgomery Basin. During recent years a large amount of work in development has been done in Montgomery County by the Virginia Anthracite Coal Co. Prior to 1904 all of the coal mined was from comparatively small mines, the product being consumed in the immediate vicinity.

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[1] See also Bull. 341, U. S. Geol. Sur., 1909, pp. 411-418.
[2] See map accompanying description of West Virginia coal fields.

WASHINGTON.

Total production in 1910, 3,911,899 short tons; spot value, $9,764,465.

Washington is the only one of the Pacific coast States in which coal mining is an industry of any importance, the total production of California and Oregon in 1910 being less than 75,000 short tons. There was in Washington, however, notwithstanding the renewed and increased aggression of fuel oil, a substantial increase in the production of coal, particularly at the commercial mines. The "railroad mines," or those operated by the railroads or subsidiary companies for the exclusive use of the railroads themselves, also showed an increased production. The total output of the State in 1910 was 3,911,899 short tons, valued at $9,764,465, against 3,602,263 tons, valued at $9,158,999, in 1909, an increase in 1910 of 309,636 short tons, or 8.60 per cent, in quantity, and of $605,466, or 6.61 per cent, in value. This increase was much less than was indicated in the earlier estimates, and the preliminary review of the coal trade in 1910, published in January, 1911, stated that the increase would amount to approximately 1,000,000 tons. The preliminary statement was based entirely upon estimates and the extent to which fuel oil had influenced the Washington production. What that influence upon the coal-mining industry of Washington will ultimately amount to is a problem. During 1910 the Northern Pacific Railway equipped 30 oil-burning locomotives for yard and switching service, and the Chicago, Milwaukee & Puget Sound and the Great Northern railways have announced their intention of using oil exclusively throughout their mountain divisions.

The most significant gain in 1910 was made in Pierce County, whose output increased from 609,467 short tons to 786,096 tons. Kittitas County, more than 85 per cent of whose production is controlled and consumed by the Northern Pacific Railway, and which is the leading coal-producing county, increased its production from 1,550,539 tons in 1909 to 1,661,650 tons. King County, next to Kittitas in importance, had a relatively small increase, from 1,216,012 tons to 1,242,340 tons, while Lewis County increased its production from 121,573 tons to 179,484 tons. Yakima County, which reported a small production in 1909, did not report any output for 1910, and the combined production of Thurston and Whatcom counties decreased.

Only one company reported using machines for mining coal in 1910, and although the total number of machines in use decreased from 18 to 10 the tonnage won by them increased from 48,690 to 56,000. The mining machines used were of the post-puncher type adapted to steeply inclined beds.

The coal mines of Washington gave employment in 1910 to 6,314 men, who worked an average of 256 days of 8 hours. The average production for each man employed was 620 tons for the year and 2.42 tons for each working day. In 1908, when 5,484 men were employed for an average of 202 days, the average production per man was 552 tons for the year and 2.73 tons per day.

The statistics of production, by counties, in 1909 and 1910, with the distribution of the product for consumption, are shown in the following table:

Coal production of Washington in 1909 and 1910, by counties, in short tons.

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 [a]	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

1910.

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	1,070,948	107,404	63,988	....	1,242,340	$2,828,123	$2.28	258	2,014
Kittitas	1,602,766	16,112	42,772	....	1,661,650	4,693,297	2.82	244	2,443
Lewis	160,743	11,745	6,996	....	179,484	377,530	2.10	230	254
Pierce	646,465	5,474	40,115	94,042	786,096	1,788,110	2.27	276	1,533
Other counties [b]	41,425	196	708	....	42,329	77,405	1.83	251	70
Total	3,522,347	140,931	154,579	94,042	3,911,899	9,764,465	2.50	256	6,314

[a] Thurston, Whatcom, and Yakima.
[b] Thurston and Whatcom.

The statistics of production, by counties, during the last five years, with increase and decrease in 1910 as compared with 1909, are shown in the following table:

Production of coal in Washington, 1906–1910, by counties, in short tons.

County.	1906	1907	1908	1909	1910	Increase (+) or decrease (−), 1910.
Cowlitz	[a] 3,523	[a] 7,424	([b])	([b])	([b])	....
King	1,310,530	1,445,633	931,643	1,216,012	1,242,340	+ 26,328
Kittitas	1,422,612	1,524,887	1,414,621	1,550,539	1,661,650	+ 111,111
Lewis	25,880	103,539	73,675	121,573	179,484	+ 57,911
Pierce	513,639	572,169	551,678	609,467	786,096	+ 176,629
Whatcom	....	....	([c])	([c])	([c])	....
Other counties	....	26,880	53,326	[d] 104,672	42,329	− 62,343
Total	3,276,184	3,680,532	3,024,943	3,602,263	3,911,899	+ 309,636
Total value	$5,908,434	$7,679,801	$6,690,412	$9,158,999	$9,764,465	+$605,466

[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, 1860–1910, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1860	5,374	1874	30,352	1888	1,215,750	1902	2,681,214
1861	6,000	1875	99,568	1889	1,030,578	1903	3,193,273
1862	7,000	1876	110,342	1890	1,263,689	1904	3,137,681
1863	8,000	1877	120,896	1891	1,056,249	1905	2,864,926
1864	10,060	1878	131,660	1892	1,213,427	1906	3,276,184
1865	12,000	1879	142,666	1893	1,264,877	1907	3,680,532
1866	13,000	1880	145,015	1894	1,106,470	1908	3,024,943
1867	14,500	1881	196,000	1895	1,191,410	1909	3,602,263
1868	15,000	1882	177,340	1896	1,195,504	1910	3,911,899
1869	16,200	1883	244,990	1897	1,434,112		
1870	17,844	1884	166,936	1898	1,884,571	Total	53,647,802
1871	20,000	1885	380,250	1899	2,029,881		
1872	23,000	1886	423,525	1900	2,474,093		
1873	26,000	1887	772,601	1901	2,578,217		

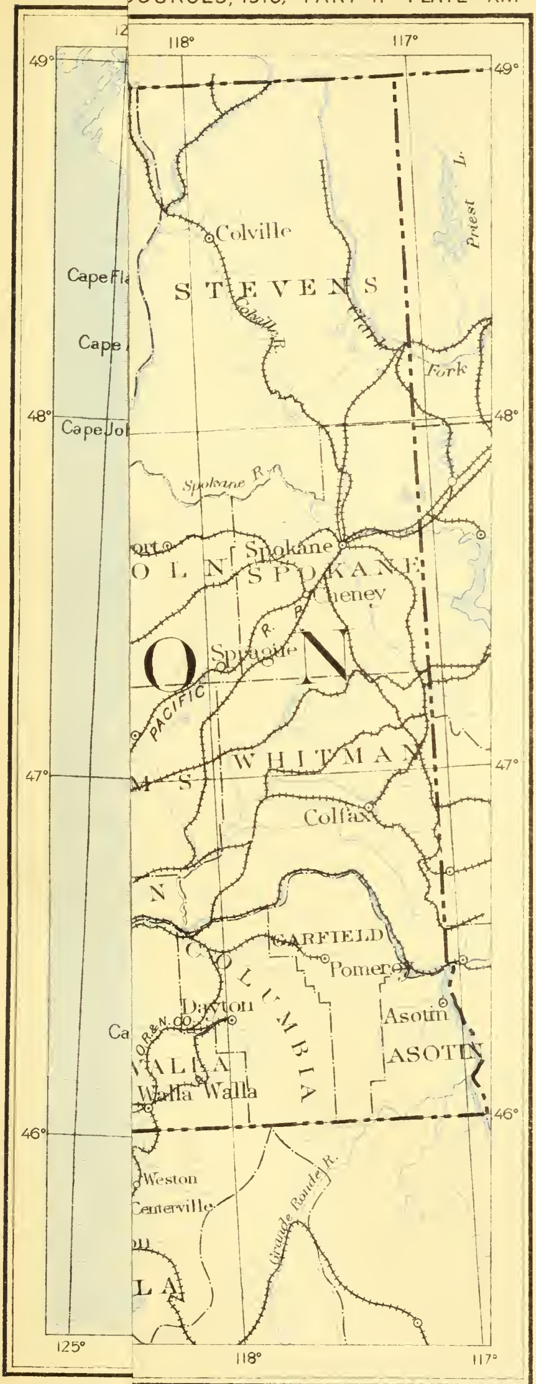
THE COAL FIELDS OF WASHINGTON.

The coal fields of Washington (Pl. XIII) are confined to the western and central portions of the State. Five principal fields may be mentioned: The North Puget Sound field, including the coal mines of Skagit and Whatcom counties; the South Puget Sound field, containing the operations in King and Pierce counties; the Puget Sound basin, just east of Seattle; the Roslyn field, in Kittitas County, on the eastern slope of the Cascade Mountains; and the Southwestern field, embracing the counties of Lewis and Cowlitz.

The coals of Washington range from subbituminous to bituminous coking coals, and some natural coke and anthracite have been observed. The bituminous coking coals of Washington are the only coking coals on the Pacific slope of the United States. They are found in the Wilkeson-Carbonado district, in the South Puget Sound field and in the North Puget Sound field, but at present coke is made only in the first-named district. The Wilkeson-Carbonado coal runs high in ash and is usually washed before coking. The subbituminous coals of Newcastle and Renton, in the South Puget Sound field, are generally of high grade and well suited for domestic use. The steamship consumption in trade with Alaska and the Orient is now the most important market for the high-grade bituminous coals of Washington.

Coal was first discovered in Washington in 1848, when a lignite of rather low grade was found in the Cowlitz Valley. Four years later bituminous coal was discovered on Bellingham Bay, Whatcom County, and the first mine in the State was opened on this bed. Shipments did not begin, however, until 1860. This mine was operated continuously from 1860 until 1878, when on account of a fire caused by spontaneous combustion the workings were abandoned, and they have not since been reopened. Shipments were not resumed from any of the mines in the northern district until 13 years later in 1891. Coal was discovered in King County in 1859, and mining began near the present Issaquah in 1862. Shipments to San Francisco began in 1871, since which time the Washington mines have been an important source of coal supply to the San Francisco market. About the same time the Talbot and the Renton mines, which are in King County, began shipping, and rail connection between the Renton mines and Seattle was obtained in 1877. Production in the Green

U.S. G
GEORGE [cut off] SOURCES, 1910, PART II PLATE XIII

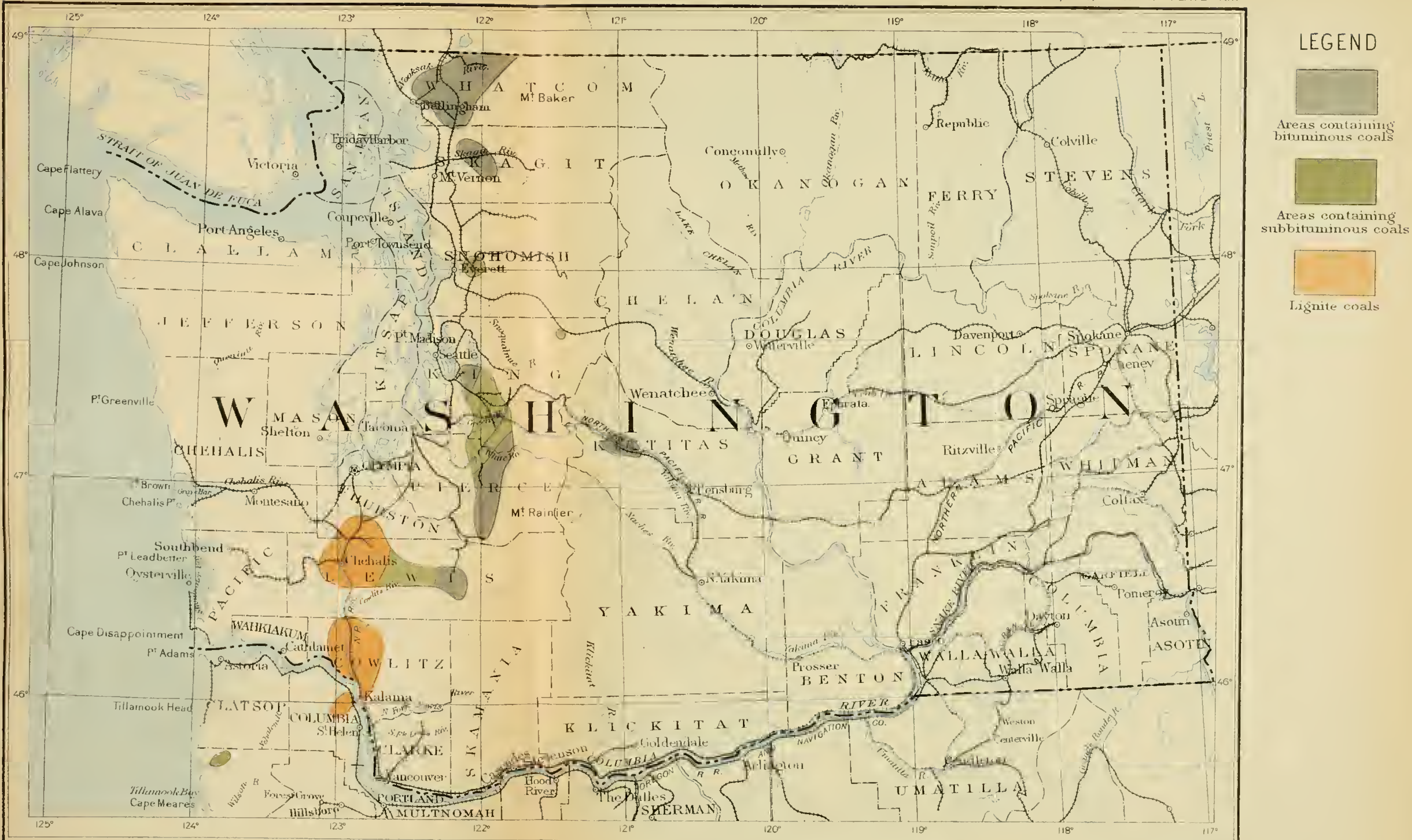


LEGEND

Areas containing bituminous coals

Areas containing subbituminous coals

Lignite coals



COAL FIELDS OF WASHINGTON

Scale $\frac{1}{2500000}$

25 0 25 50 75 100 Miles

1911

River field, also in King County, began between 1880 and 1885; and the Pierce County fields, which had been opened in 1875 and afterwards abandoned, again began shipping about the same time. The Roslyn mines, on the east side of the Cascade Range, were opened in the first half of the same decade. The Bellingham Bay mines in the first year of their recorded production, 1860, shipped 5,374 tons. In 1910 Washington's output of coal was 3,911,899 short tons.

The production of coal in Washington from the time when coal mining first began, in 1860, has amounted to 53,647,802 tons, representing an exhaustion of approximately 80,000,000 tons. Mr. Campbell estimates the original coal supply of the State of Washington as 20,000,000,000 short tons, of which the exhaustion to the close of 1910 represented 0.4 of 1 per cent. According to these estimates, the quantity of coal still in the ground at the close of 1910 was 19,920,000,000 tons, or 5,102 times the production of 1910 and 3,400 times the exhaustion represented by that output.

WEST VIRGINIA.

Total production in 1910, 61,671,019 short tons; spot value, $56,665,061.

West Virginia may now be considered firmly established in second place among the coal-producing States, though its big lead over Illinois in 1910 was due to abnormal conditions and may not be repeated for several years. The most influential feature of the coal-mining industry in 1910 was the strike in States of the Middle West, which put West Virginia's rival, Illinois, at a decided disadvantage, most of the larger mines of the latter State being completely shut down, while West Virginia got the benefit. The effect of the strike, as shown by the statistics of production in Illinois and West Virginia, was a decrease in the output of the Illinois mines from 50,904,990 short tons in 1909 to 45,898,846 short tons in 1910, whereas the production of West Virginia increased from 51,849,220 short tons to 61,671,019 tons, a gain of 9,821,799 tons, or 18.9 per cent. The value of the West Virginia production increased from $44,661,716 in 1909 to $56,665,061 in 1910, a gain of $12,003,345, or 26.88 per cent.

In spite of the fact, however, that the output of West Virginia exceeded that of Illinois by 15,772,173 tons, and of the further fact that West Virginia's gain in value was considerably more in proportion than the gain in tonnage, the total value of the West Virginia product exceeded that of Illinois by only $4,261,434. Two reasons exist for this. In the first place, mining rates are higher in Illinois than in West Virginia, and a higher price is necessary. But what makes the higher price possible is, in the second place, the great advantage possessed by Illinois in the large manufacturing industries within the State or in immediately adjoining territory. West Virginia has an advantage in the superior quality of coal, but this is largely discounted by the lack of local markets and the necessity, under present conditions at least, of shipping the product to distant points. Although bountifully supplied by nature with bituminous coal of the highest quality and now ranking second among the coal-producing States (producing, by the way, more coal than any country outside of the United States except Great Britain and Germany), West Virginia ranks twenty-ninth in the value of its manufactures. Probably the larger part of the West Virginia coal consumed within the State is that burned in the locomotives hauling it away. Moreover, the high-quality coal of West Virginia is the lowest priced coal in the United States. With the exception of the small mines' production, there were only three counties in the State whose average price in 1910 exceeded $1 per ton, and the aggregate output of these three counties was only a little over 1,000,000 tons, less than 2 per cent of the total production. The general average for the State was 92 cents. In 1909 it was 86 cents.

The increased production in 1910 was generally distributed over the State, there being but three counties which showed decreases, and the total decrease in these three counties was less than 50,000 tons. The principal gains were made in McDowell County (1,523,240 tons), Kanawha County (1,433,349 tons), Harrison County (1,256,013 tons), Raleigh County (935,616 tons), Logan County (748,363 tons), and Marion County (600,076 tons). The most significant increases, measured by percentage, were those of Harrison and Raleigh counties, each gaining nearly 40 per cent. Raleigh County's increase was more than the total production of the county five years before.

The average number of men employed in the coal mines of West Virginia in 1910 was 68,663, who worked an average of 228 days in the production of 61,671,019 short tons of coal. In 1909, according to the Bureau of the Census, 55,433 men were employed, but the working time, as compiled by the Census Office, is not comparable with the figures for other years, as compiled by the Geological Survey. In 1908, when the production amounted to 41,897,843 short tons, there were 56,861 men employed and the average working time reported was 185 days. The average production per man in 1908 was 737 short tons; in 1910 it was 898 tons. The average daily production per man was 3.98 tons in 1908 and 3.94 tons in 1910.

With the other advances in the development of West Virginia's coal-mining industry the use of mining machinery has not only kept pace, but has steadily increased in greater proportion than is shown by the increase in tonnage. In 1910 out of a total of 61,671,019 short tons, 27,981,617 short tons, or 45.37 per cent, were machine mined; in 1909 the machine-mined production was 20,993,489 tons, or 40.8 per cent of the total. In 1900, ten years earlier than the year under review, only 15.1 per cent of West Virginia's product was undercut by machines. The number of machines in use in 1910 was 1,970, against 1,844 in 1909, an increase of 126. Of the 1,970 machines in use in 1910, 680 were punchers, 1,082 were chain-breast, 201 were long-wall, 6 were of the short-wall, or continuous-cutter type, and 1 was reported as a rotary machine.

Mr. John Laing, the chief of the West Virginia Department of Mines, reports that in the fiscal year ended June 30, 1910, there were 320 fatal and 942 nonfatal accidents in the coal mines of the State. The production for the same fiscal year, as compiled by Mr. Laing, was 62,592,667 short tons, from which it appears that there were 195,602 tons mined for each life lost. The death rate per thousand employees was 4.66.

The statistics of production, by counties, in 1909 and 1910, with the distribution of the production for consumption, are shown in the following table:

Coal production of West Virginia in 1909 and 1910, by counties, in short tons.

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[a] 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

1910.

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	1,224,710	13,006	22,394	108,281	1,368,391	$1,036,659	$0.76	261	1,211
Braxton	164,773	1,761	589	....	167,123	146,556	.87	246	146
Brooke	461,551	5,589	3,534	....	470,674	482,886	1.03	278	594
Clay	33,443	6,193	4,966	....	44,602	49,371	1.11	194	76
Fayette	8,915,502	115,048	233,670	1,146,763	10,410,983	10,135,369	.97	219	13,501
Gilmer	41,440	3,526	224	....	45,190	38,200	.85	214	49
Grant	268,765	764	13,543	....	283,072	235,057	.83	245	341
Harrison	4,579,030	13,177	42,066	7,031	4,641,304	3,814,791	.80	222	4,368
Kanawha	6,792,490	101,782	91,915	24,300	7,010,487	6,518,055	.93	222	8,271
Lincoln	70,873	794	250	....	71,917	67,566	.94	254	122
Logan	2,846,936	15,642	33,750	....	2,896,328	2,657,097	.92	227	2,395
McDowell	9,915,587	176,305	250,859	3,145,325	13,488,076	12,767,998	.95	224	14,335
Marion	4,598,294	20,436	93,412	83,407	4,795,549	4,165,737	.87	244	4,171
Marshall	383,749	144,348	10,305	....	538,402	530,045	.98	232	569
Mason	195,428	21,388	4,401	....	221,217	203,906	.92	221	354
Mercer	2,291,338	29,846	46,161	509,489	2,876,834	2,603,126	.91	232	3,041
Mineral	874,258	5,192	4,136	....	883,586	798,609	.90	246	907
Mingo	2,380,206	22,274	40,150	....	2,442,630	2,170,289	.88	246	2,873
Monongalia	297,599	10,479	9,354	236,641	554,073	503,088	.91	279	480
Ohio	236,906	70,767	1,376	....	309,049	301,851	.98	272	371
Preston	717,578	7,772	23,175	415,857	1,164,382	856,866	.73	239	1,398
Putnam	522,181	7,599	10,852	....	540,632	612,001	1.13	262	979
Raleigh	3,249,937	32,637	64,555	....	3,347,129	3,309,678	.99	203	4,829
Randolph	405,950	7,806	7,085	180,066	600,907	481,840	.80	208	675
Taylor	694,110	5,794	5,890	13,436	719,230	525,660	.73	230	765
Tucker	1,025,674	6,832	35,125	250,336	1,317,967	1,184,590	.90	266	1,256
Upshur	84,291	6,201	2,268	....	92,760	70,007	.75	180	104
Other counties[b] and small mines	289,919	70,956	4,637	3,013	368,525	398,163	1.08	241	482
Total	53,562,518	923,914	1,060,642	6,123,945	61,671,019	56,665,061	.92	228	68,663

[a] Boone, Greenbrier, Hancock, Lewis, Ritchie, and Wood.
[b] Boone, Greenbrier, Hancock, Lewis, Nicholas, Ritchie, Wayne, and Wood.

The statistics of production, by counties, during the last five years, with increase and decrease in 1910, as compared with 1909, are shown in the following table:

Coal production of West Virginia, by counties, 1909–1910, in short tons.

County.	1906	1907	1908	1909	1910	Increase (+) or decrease (–), 1910.
Barbour	993,681	1,175,763	1,023,029	1,024,805	1,368,391	+ 343,586
Braxton				105,714	167,123	+ 61,409
Brooke	483,256	454,119	433,373	380,887	470,674	+ 89,787
Clay	79,385	63,747	6,622	43,212	44,602	+ 1,390
Fayette	8.260,307	8,599,978	7,663,561	9,877,521	10,410,983	+ 533,462
Gilmer				40,201	45,190	+ 4,989
Grant	297,026	312,407	217,074	190,575	283,072	+ 92,497
Hancock	70,251	87,100	85,631	75,633	71,211	– 4,422
Harrison	3,626,337	3,939,965	3,262,637	3,385,291	4,641,304	+ 1,256,013
Kanawha	4,880,307	5,588,074	4,630,548	5,577,138	7,010,487	+ 1,433,349
Lincoln				51,227	71,917	+ 20,690
Logan	592,895	1,248,522	1,683,456	2,147,965	2,896,328	+ 748,363
McDowell	8,707,677	9,840,975	8,601,802	11,964,836	13,488,076	+ 1,523,240
Marion	4,163,462	4,228,231	3,922,398	4,195,473	4,795,549	+ 600,076
Marshall	511,335	612,605	259,769	356,619	538,402	+ 181,783
Mason	112,660	150,726	119,723	117,209	221,217	+ 104,008
Mercer	2,199,830	2,344,426	2,088,343	2,511,000	2,876,834	+ 365,834
Mineral	661,938	746,668	696,226	892,245	883,586	– 8,659
Mingo	2,210,276	2,229,436	1,800,589	2,039,640	2,442,630	+ 402,990
Monongalia	328,408	424,997	224,955	371,890	554,073	+ 182,183
Nicholas	79,635	82,246	41,629	36,714	79,714	+ 43,000
Ohio	121,464	187,545	145,987	236,870	309,049	+ 72,179
Preston	1,129,344	1,286,535	659,348	996,767	1,164,382	+ 167,615
Putnam	548,725	437,073	532,446	575,009	540,632	– 34,377
Raleigh	1,105,318	1,412,393	1,622,161	2,411,513	3,347,129	+ 935,616
Randolph	387,762	671,417	361,851	392,846	600,907	+ 208,061
Taylor	445,427	475,237	489,069	483,906	719,230	+ 235,324
Tucker	1,199,041	1,217,267	980,425	1,157,753	1,317,967	+ 160,214
Upshur				80,615	92,760	+ 12,145
Other counties and small mines	94,603	274,131	345,191	128,146	217,600	+ 89,454
Total	43,290,350	48,091,583	41,897,843	51,849,220	61,671,019	+ 9,821,799
Total value	$41,051,939	$47,846,630	$40,009,054	$44,661,716	$56,665,061	+$12,003,345

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 & Ohio Railroad and sends its coal to market over that highway. The upper Potomac region also is reached by the Baltimore & Ohio Railroad and is penetrated by the West Virginia Central & Pittsburg Railway. The Pocahontas, or Flat Top, region is tributary to the main branch of the Norfolk & Western Railway. All of the product of this district goes either west or to tidewater 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 & Ohio Railway and the Kanawha & Michigan Railway, which pass through it, and partly by barges on Kanawha River. The Virginian Railway, to which reference has already been made, affords 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, 1886–1910, 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
1910	21,433,547	22,891,014	13,242,929	2,484,625

[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 1910 are shown in the following table:

Production of coal in West Virginia from 1863 to the close of 1910, 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	1910	61,671,019
1872	700,000	1885	3,369,062	1898	16,700,999		
1873	1,000,000	1886	4,005,796	1899	19,252,995	Total.	589,616,621
1874	1,120,000	1887	4,881,620	1900	22,647,207		
1875	1,120,000	1888	5,498,800	1901	24,068,402		

THE COAL FIELDS OF WEST VIRGINIA.

The coal-producing area of West Virginia (Pl. XIV) is included in the coal fields of the Appalachian region, which crosses the State from Pennsylvania and Maryland on the north to Virginia and Kentucky on the south. Only the area lying to the east of the escarpment of the Allegheny Mountains is outside of the coal-bearing rocks, although portions of the region lying south of Ohio River below Wetzel are said, by Dr. I. C. White, State geologist, to be barren of workable coal. All of the coals of West Virginia are bituminous or semibituminous, but some cannel and a peculiar type known as Kanawha splint are mined in the southern part of the State. One of the most important coals is the celebrated Pittsburg bed of Pennsylvania, which extends over considerable portions of West Virginia and Ohio.

Of West Virginia's total production about 90 per cent comes from five principal mining districts, and nearly all of the other 10 per cent comes from three smaller districts. The more important of these are the Fairmont, or Clarksburg, and the Piedmont, or Elk Garden, fields in the northern portion of the State, and the New River, Kanawha, and Pocahontas fields in the southern portion.

The Fairmont or Clarksburg region lies principally in Harrison and Marion counties, the beds from which the coal is mined here belonging to the Monongahela formation ("Upper Productive Coal Measures"). The most important bed is the Pittsburg, which has an average thickness of 8 feet 6 inches, of which 7 feet are usually mined. The Waynesburg and Sewickley coals, the former poor and the latter good, also occur in this district, and run from 5 to 10 feet in thickness, but are seldom mined. The field is traversed by several lines of the Baltimore & Ohio Railroad, which furnishes transportation for the product.

The Piedmont or Elk Garden field was the first to be worked in West Virginia, coal having been mined in this district before the State was separated from the mother State of Virginia, and also contemponeously with the opening of the Cumberland, or Georges Creek, field in Maryland. It lies in the detached Potomac basin and is included in Mineral, Grant, and Tucker Counties. The strata of this narrow eastern basin are much more strongly folded than are those of the regions to the west. The coal is semibituminous. The principal coals worked are the "Big" bed (Pittsburg) of Monongahela age, and the "Thomas" (Upper Freeport) and "Davis" (Upper (?) Kittanning) of Allegheny age. They range from 4 to 11 feet in thickness. Transportation is afforded by the Baltimore & Ohio and the West Virginia Central & Pittsburg railroads, the latter being now a portion of the Wabash system.

The New River field, as at present outlined, is confined to the valley of New River and its tributaries, and to the Slab Fork and Winding Gulf drainage areas of Guyan River. The productive portions are in Fayette and Raleigh counties. The coals of this district are of middle and lower Pottsville age, and lie below the Kanawha formation (of upper Pottsville age) and the Allegheny formation ("Lower Productive Coal Measures") of the northern part of the State. The three coal beds which furnish the larger part of the New River product are the Sewell, which runs from 2 feet 6 inches to 5 feet, the Beckley, 4 feet to 6 inches, and the Quinnimont, from 3 feet to 5

ERN KENTUCKY

COAL FIELDS OF MARYLAND, VIRGINIA, WEST VIRGINIA, AND EASTERN KENTUCKY

Scale $\frac{1}{2500000}$

25 0 25 50 75 100 Miles

feet in thickness, the last named lying below and to the southeast of the others. The coal is of the "smokeless" coking variety, not unlike in quality that of the Piedmont field. One seam of coal, belonging properly to the Kanawha field and the upper Pottsville, lies high in the hills in the New River district, and is extensively mined at Ansted, in Fayette County. The district is penetrated by the Chesapeake & Ohio Railway and the Virginian Railway.

The Kanawha field lies immediately west of the New River field and includes the western portion of Fayette County, all of Kanawha County, and portions of Putnam and Boone counties. It is drained by the Kanawha, Coal, and Elk rivers. The coals of this field occur at a higher geological horizon than those of the New River district and belong, for the most part, to the Kanawha formation, of upper Pottsville age, though one or two coals of Allegheny age are also worked to a limited extent. The coals are variable in character and thickness. The beds usually vary from 3 to 5 feet in thickness where mined, but in some cases reach a thickness of 11 feet or more. A considerable portion of the coal is a high-grade, gas-producing fuel, Kanawha gas coal having an excellent reputation as a gas-producer. The principal beds are designated as the North Coalburg and the No. 5, of Allegheny age; and the Stockton, the Coalburg, the Winifrede, the Cedar Grove, "No. 2, gas," and the Eagle, in the upper Pottsville. Transportation is furnished by the Chesapeake & Ohio, the Kanawha & Michigan, the recently constructed Coal & Coke, and the Virginian ("Deepwater-Tidewater") railroads. The slackwater navigation of the Kanawha River also affords an outlet to market for the Kanawha coals.

The Pocahontas field lies in the southeastern corner of the State, in McDowell and Mercer counties, and extends across the State line into Tazewell County, Va. The coal mined in the Pocahontas, or No. 3 seam, is from 4 to 11 feet in thickness, averaging over 6 feet. During the last few years a large amount of development has been done on Pocahontas No. 4, the War Creek (Beckley), the Welch, and the Davey (supposed equivalent of the Sewell) beds, and shipments from these beds, especially No. 4, have reached an important character. All of these beds except the middle Pottsville coals (Welch and Davey), occur in the lower Pottsville. All of the Pocahontas coal is a high-grade, semibituminous variety, one of the purest coals occurring in the United States. As a coke producer it is the great rival to the Connellsville coal of Pennsylvania. As steam fuels the Pocahontas and the New River coals rank with the highest grade Georges Creek, or Cumberland of Maryland, and the best Clearfield coals of Pennsylvania. The Pocahontas district is penetrated by the Norfolk & Western Railway and the Virginian Railway, over which the product is shipped to market.

The smaller fields include the coals of the Big Sandy in Mingo and Logan counties, in the southern portion of the State, this being in reality a continuation of the Kanawha field, with transportation afforded by the Norfolk & Western Railway; of the Philippi field, in Preston, Barbour, and Randolph counties, which is of Allegheny age ("Lower Productive Measures"); and of the Wheeling field, which includes the counties in the Panhandle along the Ohio River, where the Pittsburgh coal is mined.

The statistics of production in West Virginia since 1863, when the State was formed out of Virginia, are shown in the table on a preceding page, giving the production of coal in the United States from the date of earliest recorded production to the close of 1910.

The total production of coal in West Virginia to the close of 1910 amounted to 589,616,621 short tons, equivalent to an exhaustion of 880,000,000 tons. Estimates by M. R. Campbell and I. C. White, State geologist of West Virginia, place the original supply of coal before mining began at 150,000,000,000 short tons. Deducting the exhaustion to the close of 1910, 149,120,000,000 short tons of coal or 99.4 per cent of the original supply still remain available.

WYOMING.

Total production in 1910, 7,533,088 short tons; spot value, $11,706,187.

Wyoming, like most of the States in the Rocky Mountain section, exceeded in 1910 all previous records in the quantity and value of its coal production. From an output of 6,393,109 short tons valued at $9,896,848 in 1909, the production increased to 7,533,088 short tons valued at $11,706,187. The increase was $1,139,979 short tons, or 17.83 per cent, in quantity and $1,809,339, or 18.28 per cent, in value. As was the case in Colorado and New Mexico, the gain in Wyoming's output and the advance in price were due to the shortage of coal for railroad, manufacturing, and domestic use in the States to the east, caused by the six months' strike among the miners in the Central and Southwestern States.

With the exception of Converse County, whose production at best is relatively small, and the output reported from local banks, the increase in production in 1910 was general throughout the State. The most important increases were in Sheridan, Sweetwater, and Uinta counties, whose gains were, respectively, 333,189 tons, 233,589 tons, and 374,351 tons.

The number of men reported as engaged in the production of coal in Wyoming in 1910 was 7,771, who averaged 248 working days. The average production for the year by each employee was 969 tons, and 3.91 tons for each working day. Comparisons with 1909 are not possible owing to the manner in which the labor statistics were compiled by the Bureau of the Census, but in 1908, when 6,915 men working an average of 217 days produced 5,489,902 tons, the average production per man was 794 tons for the year, and 3.66 tons for each working day.

Of the total production of 7,533,088 tons in 1910, 1,468,994 tons were undercut by the use of machines. In 1909 1,430,551 tons were machine-mined. The number of machines in use in 1910 was 98 against 127 in 1909.

Altogether in 1910 there were 1,196 men on strike in the coal mines of Wyoming, but as they lost only an average of 11 days each, the idleness did not affect the production.

The statistics of production, by counties, in 1909 and 1910, with the distribution of the production for consumption, are shown in the following table:

Coal production of Wyoming in 1909 and 1910, by counties, in short tons.

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 [a]	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

1910.

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	170,315	5,644	5,300	181,259	$303,728	$1.68	206	197
Carbon	638,731	6,802	20,126	665,659	1,030,874	1.55	283	627
Converse	5,400	2,000	1,550	8,950	16,500	1.84	193	56
Sheridan	1,246,202	21,313	35,839	1,303,354	1,645,024	1.26	203	1,457
Sweetwater	2,785,089	12,902	77,458	2,875,449	4,710,977	1.64	261	2,952
Uinta	1,824,044	22,430	114,197	1,960,671	3,017,673	1.54	249	1,966
Other counties [b]	490,551	15,228	29,738	535,517	976,113	1.82	278	516
Small mines		2,229		2,229	5,298	2.38		
Total	7,160,332	88,548	284,208	7,533,088	11,706,187	1.55	248	7,771

[a] Carbon, Converse, Crook, Fremont, Johnson, Park, and Weston.
[b] 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 1910 as compared with 1909, are shown in the following table:

Coal production of Wyoming, 1906–1910, by counties, in short tons.

County.	1906	1907	1908	1909	1910	Increase (+) or decrease (−), 1910.
Bighorn	4,743	56,966	101,275	133,389	181,259	+ 47,870
Carbon	450,636	583,402	543,009	590,969	665,659	+ 74,690
Converse	69,495	48,700	32,745	16,885	8,950	− 7,935
Sheridan	1,014,318	1,226,221	839,533	970,165	1,303,354	+ 333,189
Sweetwater	2,121,546	2,071,842	2,180,933	2,641,860	2,875,449	+ 233,589
Uinta	2,078,772	1,889,742	1,380,488	1,586,320	1,960,671	+ 374,351
Weston	379,990	361,015	337,815	354,182	416,714	+ 62,532
Crook, Fremont, Johnson	[a] 12,929	14,362	73,170	[b] 91,751	[b] 118,803	+ 27,052
Small mines	1,565	740	934	7,588	2,229	− 5,359
Total	6,133,994	6,252,990	5,489,902	6,393,109	7,533,088	+ 1,139,979
Total value	$8,013,528	$9,732,668	$8,868,157	$9,896,848	$11,706,187	+$1,809,339

[a] Crook and Johnson only. [b] 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 1910, is shown in the following table:

Production of coal in Wyoming from 1865 to 1910, 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	5,178,550
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	1910	7,533,088
1875	300,808	1887	1,170,318	1899	3,837,392		
1876	334,550	1888	1,481,540	1900	4,014,602	Total	97,234,864

THE COAL FIELDS OF WYOMING.[1]

The estimated tonnage of coal in the ground in Wyoming exceeds that of any other State in the Union, with the possible exception of North Dakota. This great tonnage is due to (1) the large number of coal-bearing formations present in the State, (2) to the great number and thickness of the coal beds, and (3) to the size of the coal fields, about 50 per cent of the area of the State being underlain by coal-bearing formations.

The largest coal field of the State is that of Powder River, which lies in the basin or trough between the Black Hills and the Bighorn Mountains, and extends from North Platte River to the Montana line. This field is the southern extension of the great Fort Union coal region of Montana and North Dakota, and embraces in Wyoming an area of about 15,000 square miles. Of this area at least 11,000 square miles are underlain by coal beds known to be more than 3 feet thick, and the remainder may in places contain beds thick enough to work.

The next largest field is the Green River Basin in the southwestern part of the State, which contains at least 4,800 square miles of territory known to contain available coal and 1,300 square miles which may contain in places coal of sufficient thickness to mine. In addition to the area specified above there is in the center of this basin an area 20,000 square miles in extent, in which the coal-bearing formations are certainly present, but they are so deeply covered by later formations that it is doubtful if they can ever be reached.

The other fields of less importance areally are Bighorn Basin, Wind River Basin, Hannah, Hams Fork, and Mount Leidy.

The coal-bearing formations extend from the base of the Upper Cretaceous to near the middle of the Tertiary. As a rule, the older the formation the better the coal, and even within the Mesaverde formation (Upper Cretaceous) the best coal is obtained near the base of the formation. Most of the coal from the Mesaverde formation

[1] See map (Pl. VII) accompanying description of Montana coal fields.

is bituminous in character and that from the formations above the Mesaverde is subbituminous, but in the Bighorn and Wind River basins beds which are believed to represent the Mesaverde contain subbituminous coal.

Wyoming is the second largest coal-producing State in the Rocky Mountain region, Colorado ranking first, and if production in Wyoming continues to increase within the next few years as it has done in the last 25 it will soon rival Colorado for the first place. The coal mined in Wyoming is bituminous and subbituminous in character. More than half of the product comes from the Kemmerer district, in Uinta County, and from the Rock Springs field, in Sweetwater County. Both of these areas furnish medium-grade bituminous coal, as does also the small field at Cambria, in Weston County. The places producing subbituminous coal are Black Buttes, in Sweetwater County; Hannah, in Carbon County; Sheridan, in Sheridan County; Glenrock, in Converse County; and Gebo, in Bighorn County.

The fields which have not been reached by the railroad are as follows: Henrys Fork field, in southern Sweetwater County; the Rattlesnake field, in Natrona and Fremont counties; the Owl Creek Mountain field, in the Shoshone Indian Reservation in Fremont County; the Fall River Basin and the Upper Green River field, in Uinta and Fremont counties; the Mount Leidy field, the Lander Peak field, and the Grays River field, in Uinta County.

The estimate of the original coal supply of Wyoming, as made by M. R. Campbell, credited that State with the largest original supply, with the single exception of North Dakota, which is estimated to have contained originally 500,000,000,000 short tons of coal. The areas of North Dakota are, however, entirely of lignite, while in Wyoming the coal is either of bituminous or semibituminous character. Wyoming's supply is estimated to have been 424,085,000,000 short tons, compared with which the aggregate production to the close of 1910 (97,234,864 short tons) appears insignificant. The total exhaustion of the beds up to the close of 1910 amounted to 146,000,000 short tons, or 0.034 of 1 per cent of the total estimated supply.

CLASSIFIED LIST OF PAPERS DEALING WITH COAL, COKE, LIGNITE, AND PEAT CONTAINED IN PUBLICATIONS OF UNITED STATES GEOLOGICAL SURVEY.

Compiled by JOHN M. NICKLES and WILLIS T. LEE.

The following list contains the more important papers dealing with coal, coke, lignite, and peat from an economic standpoint, except the statistical reports contained in the volumes of Mineral Resources. The page references indicate whether a paper is devoted wholly or in part to these subjects.

Papers dealing with geologic work in the several States and Territories, alphabetically arranged, are given first, then those general in scope arranged in chronologic order, followed by papers on technologic subjects.

ALABAMA.

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The southern Appalachian coal field, by C. W. Hayes. Twenty-second Ann. Rept., pt. 3, 1902, pp. 227-263.

An account of the stratigraphy, distribution, and character of the coals of the Jellico, Chattanooga, and Birmingham districts, embracing parts of Kentucky, Tennessee, Georgia, and Alabama.

The Warrior coal basin in the Brookwood quadrangle, Alabama, by Charles Butts. Bull. 260, 1905, pp. 357-381.

The Warrior coal basin in the Birmingham quadrangle, Alabama, by Charles Butts. Bull. 285, 1906, pp. 211-222.

The northern part of the Cahaba coal field, Alabama, by Charles Butts. Bull. 316, 1907, pp. 76-115.

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The southern part of the Cahaba coal field, Alabama, by Charles Butts. Bull. 431, 1911, pp. 89-146.

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ALASKA.

Report on coal and lignite of Alaska, by W. H. Dall. Seventeenth Ann. Rept., pt. 1, 1896, pp. 763-834.

The coal resources of Alaska, by A. H. Brooks. Twenty-second Ann. Rept., pt. 3, 1902, pp. 515-571.

Coal resources of the Yukon Basin, Alaska, by A. J. Collier. Bull. 213, 1903, pp. 276-283.

The coal resources of the Yukon, Alaska, by A. J. Collier. Bull. 218, 1903, 71 pp.

Petroleum fields of Alaska and the Bering River coal fields, by G. C. Martin. Bull. 225, 1904, pp. 371-375.

The petroleum fields of the Pacific coast of Alaska, with an account of the Bering River coal deposits, by G. C. Martin. Bull. 250, 1905, pp. 27-36.

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Coal resources of southwestern Alaska, by R. W. Stone. Bull. 259, 1905, pp. 151-171.

Coal fields of the Cape Lisburne region, by A. J. Collier. Bull. 259, 1905, pp. 172-185.

Mineral resources of the Kenai Peninsula; coal fields of the Kachemak Bay region, by R. W. Stone. Bull. 277, 1906, pp. 53-73.

Geology and coal resources of the Cape Lisburne region, Alaska, by A. J. Collier. Bull. 278, 1906, 54 pp.

Markets for Alaska coal, by G. C. Martin. Bull. 284, 1906, pp. 18-29.

Distribution and character of the Bering River coal, by G. C. Martin. Bull. 284, 1906, pp. 65-77.

Preliminary statement on the Matanuska coal field, by G. C. Martin. Bull. 284, 1906, pp. 88-100.

The Herendeen Bay coal field, by Sidney Paige. Bull. 284, 1906, pp. 101-108.

A reconnaissance of Admiralty Island, by C. W. Wright. Bull. 287, 1906, pp. 151-154.

A reconnaissance of the Matanuska coal field, Alaska, in 1905, by G. C. Martin. Bull. 289, 1906, 36 pp.

The Alaska coal fields, by G. C. Martin. Bull. 314, 1907, pp. 40-46.

Reconnaissance in the Matanuska and Talkeetna Basins, with notes on the placers of the adjacent region, by Sidney Paige and Adolph Knopf. Bull. 314, 1907, pp. 109-115.

The Bonnifield and Kantishna regions, by L. M. Prindle. Bull. 314, 1907, pp. 221-226.

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Mineral resources of the Bonnifield region, by S. R. Capps. Bull. 480, 1911, pp. 231-235.

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The Black Mesa coal field, Arizona, by M. R. Campbell and H. E. Gregory. Bull. 431, 1911, pp. 229-238.

Coal deposits near Pinedale, Navajo County, Ariz., by A. C. Veatch. Bull. 431, 1911, pp. 239-242.

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The South Park coal field, Colorado, by C. W. Washburne. Bull. 381, 1910, pp. 307–316.

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The Trinidad coal field, Colorado, by G. B. Richardson. Bull. 381, 1910, pp. 379–446.

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Stratigraphy and coal beds of the Indiana coal field, by G. H. Ashley. Bull. 381, 1910, pp. 9–18.

INDIAN TERRITORY. *See* Oklahoma.

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Joplin district folio, Missouri-Kansas, description, by W. S. T. Smith and C. E. Siebenthal. Geologic Atlas U. S., folio 148, 1907, pp. 19–20.

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The coal-fields of parts of Dawson, Rosebud, and Custer Counties, Mont., by A. G. Leonard. Bull. 316, 1907, pp. 194–211.

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The Red Lodge coal field, Montana, by E. G. Woodruff. Bull. 341, 1909, pp. 92–107.

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Preliminary report on the geology and underground water resources of the central Great Plains, by N. H. Darton. Prof. Paper 32, 1905, pp. 372–379.

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COKE.

By Edward W. Parker.

INTRODUCTION.

Coke, as considered in this and the preceding chapters of the series, is the product obtained by subjecting certain grades of bituminous coal to high temperatures in chambers from which either the air is entirely excluded or into which only a sufficient quantity of air is admitted to secure, supposedly, the combustion of the volatile contents of the coal. The process, consequently, is one either of distillation or of partial combustion. When the process is one of distillation, the coal, usually crushed to one-half inch or smaller, is charged into chambers or retorts approximately 30 feet long, 6 to 8 feet high, and from 17 to 22 inches wide, the heat being applied by the combustion, in flues arranged vertically or horizontally between the coking chambers, of gases distilled from the coal. Such coking chambers or ovens are known as retort ovens and are usually, but not always, designed for the recovery of the by-products of tar and ammonia and of the "surplus" gas—that is, the gas over and above that required for the heating of the ovens. The common coke-making practice in the United States has been that of partial combustion in ovens having the shape of the conventional beehive, and to which the name of beehive oven has been given. In this type of oven no attempt is made to recover any of the constituents of the coal except the fixed carbon or coke, though in isolated instances the burning gases have been utilized for the generation of heat, light, and power. During the last three years a new type of oven has been meeting with favor in some of the coking districts. It is a modification of the beehive oven, but instead of being built in circular form, like the beehive oven, is of rectangular construction and of such dimensions that the coke may be pushed instead of drawn from the coking chambers. At the close of 1910 there were 2,330 ovens of this type in operation and 612 in course of construction.

The coke product obtained in either the distillation or the partial-combustion process 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, screened, and sold for domestic consumption. It is a smokeless fuel and thus becomes a competitor with anthracite 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.

While noteworthy progress has been made in the substitution of modern retort-oven practice for the wasteful and what should be obsolete beehive or partial-combustion method of coke making in the United States, this country is still much behind European countries in this regard. In Belgium and in Germany, two of the principal coke-making countries of continental Europe, beehive ovens have long since been abandoned, and all of the coke is made in retorts with or without recovery of by-products. When the by-products are not recovered the oven gases in excess of the quantity required for the heating of the ovens are used in the power houses. The quantity of power derivable from each oven varies from 15 to 20 horsepower per hour. The yield of coal in coke in retort ovens exceeds that obtained in beehive or other partial-combustion ovens by about 15 per cent, and generally the quality of the coke is improved.

All of the retort ovens thus far constructed in the United States are of the by-product recovery type, but some beehive plants, notably one at Dawson, N. Mex., have been equipped with flues conducting the heated gases to the power house and utilizing them in the same manner as is accomplished with the nonrecovery retort oven. The economies effected in the operation of beehive ovens in this way are stated to be largely offset by the expenses necessary for repairs.

The by-product recovery branch of the coking industry in the United States began in 1893, when a plant of 12 Semet-Solvay ovens was completed at Syracuse, N. Y., which has since been increased to 40 ovens. The first plant of Otto-Hoffmann (now known as "United Otto") ovens was built at Johnstown, Pa., in 1895. It consisted of 60 ovens. This plant has been enlarged three times and now contains 372 ovens. From the small beginnings in 1893 and 1895 the number of plants and of ovens have increased until at the close of 1910 there were 28 by-product recovery plants with a total of 4,078 ovens, and there were 4 plants and a total of 1,200 retort ovens under construction. During the last two years there has been a marked revival in the construction of by-product recovery coke plants, and more ovens were under construction in 1909 and in 1910 than in any year since 1903.

All of the coke produced in retort ovens is a fuel suitable for metallurgical purposes, but its use, like beehive coke, is not restricted to 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. The details of the production of coke in retort ovens 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 region, contained within the States of Colorado, New Mexico, Utah, Montana, and Wyoming.

5. The Pacific coast region 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 supplies 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 1910.

The quantity of coke produced in the United States in 1910 exceeded that of any previous year in our history. The combined output of coke from beehive and retort ovens amounted in 1910 to 41,708,810 short tons, valued at $99,742,701. Compared with 1909, when the production amounted to 39,315,065 short tons, valued at $89,965,483, the record for 1910 showed an increase of 2,393,745 short tons, or 6.1 per cent, in quantity and of $9,777,218, or 10.9 per cent, in value. The highest previous record in coke production was made in 1907, when the output amounted to 40,779,564 short tons, valued at $111,539,126, compared with which the output in 1910 shows an increase of 929,246 short tons in quantity, but a decrease of $11,796,425 in value.

It may be observed that in the production of coke in 1910 there was a larger relative increase in value than in quantity, and that the average price per ton advanced from $2.29 in 1909 to $2.39 in 1910, from which it would appear that the history of coke production in 1910 was a highly satisfactory one. Such, however, was not the case, for whereas the value of the product of 1910 exceeded that of

1909 by $9,777,218, this was more than offset by the higher value of the coal charged into the ovens. The quantity of coal used in the manufacture of coke in 1909 was 59,354,937 short tons, valued at $62,203,382; in 1910 the quantity of coal used was 63,088,327 short tons, valued at $74,846,393. The increase in the value of the coal used in 1910 over 1909 was $12,643,011, or $2,865,793 more than the increase in the value of the coke. The average price of coke products showed a gain of 10 cents per ton, while the value per ton of coal used increased from $1.05 in 1909 to $1.19 in 1910, a difference of 14 cents.

Of the total production in 1910 of 41,708,810 short tons, 34,570,076 tons, or 82.88 per cent, were produced in beehive ovens or in ovens in which the process is one of partial combustion, and 7,138,734 tons, or 17.12 per cent, were produced in by-product ovens or in ovens in which the process is one of distillation. In 1909, 33,060,421 short tons, or 84.09 per cent, were produced in beehive ovens and 6,254,644, or 15.91 per cent, were produced in retort ovens. The quantity of beehive coke made in 1910 exceeded that of 1909 by 1,509,655 short tons, or 4.6 per cent, while the quantity of retort-oven coke increased 884,090 short tons, or 14.13 per cent. The average price per ton for beehive coke in 1910 was $2.17 and for retort-oven coke $3.47. The higher value for the retort-oven coke was due to the fact that most of the ovens are located at points distant from the mines and transportation expenses are borne by the coal and added to the value of the coal charged into the ovens.

In considering the total value and the average selling price for the coke produced in the United States, it should be remembered that many of 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 department 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.

As previously stated, the quantity of coal consumed in the manufacture of coke in 1910 amounted to 63,088,327 short tons, valued at $74,846,393. The value of the coke produced from this coal was $99,742,701, a difference of $24,896,308, which represented the profit on the coke-making operations, less cost of manufacture, expenses of administration, etc. In 1909 the value of the coal used was $62,203,382, and the value of the coke produced was $89,965,483, a difference of $27,762,101. In 1907, which was a year of unusual activity and prosperity in the coke-making districts, the difference between the value of the coal used and that of the coke produced was $38,754,275.

Notwithstanding the increased production and the higher value of the coke in 1910 as compared with 1909, the year was a decidedly unsatisfactory one from the producer's standpoint. It has already been noted that the increase in the value of the coal used exceeded the increase in the value of the coke produced and that the net result of the year's business was really a loss rather than a gain over the preceding year. The tendency of prices was downward from January to December, and in the latter part of the year much of the coke business was conducted at a loss.

Connellsville furnace coke, which is recognized as the standard blast-furnace fuel, declined from the high record of $2.75 in January to $1.40 in December, the values of other cokes competing with Connellsville showing a corresponding decline.

In spite of the unfavorable character of the business in 1910 there was some activity in new construction. The total number of ovens increased from 103,982 in 1909 to 104,440 in 1910, a gain of 458, and there were 2,567 ovens in course of construction at the end of the year. Of the 104,440 ovens in existence at the close of 1910, 8,373 were idle throughout the year. The number of idle ovens does not include those that were idle for a portion of the year only. In 1909, of the 103,982 ovens in existence, 8,501 were idle throughout the year. The number of ovens in blast for the whole or a portion of the year 1910 was 96,067, of which 92,016 were beehive, or partial combustion ovens, and 4,051 were retort, or distillation ovens. The 92,016 beehive ovens produced a total of 34,570,076 short tons, or an average of 376 tons for each active oven. Of the 4,078 by-product recovery ovens in existence at the close of 1910, 27 were idle through the year, leaving 4,051 ovens that made coke during 1910. The total production of the 4,051 active retort ovens was 7,138,734 short tons, or an average of 1,762 tons per oven, as compared with 376 tons as the average production for the beehive ovens. The average value per oven of the coke produced in beehive ovens was $815 and the average value per oven of the coke and by-products produced in retort ovens was $8,213, more than ten times the average value of the beehive production.

At the close of 1910 there were 2,567 ovens in course of construction. Of the ovens building 1,200, or 46.75 per cent, were by-product recovery ovens. The 1,200 retort ovens under construction in 1910 consisted of 560 Koppers ovens building by the Illinois Steel Co., at Gary, Ind.; 60 Koppers ovens building by the Woodward Iron Co., at Woodward, Ala.; 280 of the same type building for the Tennessee Coal, Iron & Railroad Co., at Corey, Ala.; and 300 Didier ovens building by the Lehigh Coke Co., at South Bethlehem, Pa. The Didier ovens will furnish coke for the Bethlehem Steel Co.'s works at South Bethlehem.

Considering each bank of ovens as a separate establishment, the returns for 1910 show a total of 578 establishments in that year, against 579 in 1909, a decrease of 1. There were 9 plants abandoned and dismantled in 1910 and 8 new ones were constructed. Of the 578 establishments in 1910, 100 establishments and a total of 8,373 ovens were idle throughout the year, compared with 105 establishments idle in 1909 and 130 in 1908. The idle establishments are mostly small ones. The average number of ovens to the idle establishments in 1910 was 84; the average to the active establishments was a little over 200 ovens.

The statistics of the production of coke in 1909 and 1910 are presented, by States and Territories, in the following table:

Manufacture of coke, by States and Territories, in 1909 and 1910.

1909.

State or Territory.	Establishments.	Ovens.		Coal used (short tons).	Yield of coal in coke (per cent).	Coke produced (short tons).	Total value of coke.	Price of coke per ton.
		Built.	Building.					
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	1.91
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

1910.

State or Territory.	Establishments.	Ovens.		Coal used (short tons).	Yield of coal in coke (per cent).	Coke produced (short tons).	Total value of coke.	Price of coke per ton.
		Built.	Building.					
Alabama	43	10,132	340	5,272,322	61.6	3,249,027	$9,165,821	$2.82
Colorado [a]	16	3,611	0	2,069,266	65.1	1,346,211	4,273,579	3.17
Georgia	2	350	0	80,019	54.8	43,814	173,049	3.95
Illinois	5	508	0	1,972,955	76.8	1,514,504	6,712,550	4.43
Kentucky	6	495	0	104,103	51.7	53,857	120,554	2.24
Missouri	1	4	0	0	....	0	0	....
New Mexico	4	1,030	0	651,494	61.6	401,646	1,306,136	3.25
Ohio	8	496	0	413,059	68.3	282,315	911,987	3.23
Pennsylvania	288	55,656	1,334	39,455,785	66.7	26,315,607	55,254,599	2.10
Tennessee	16	2,792	0	597,658	54.0	322,756	959,104	2.97
Utah	2	854	0	(b)	....	(b)	(b)	....
Virginia	18	5,389	100	2,310,742	64.6	1,493,655	2,731,348	1.83
Washington	6	285	0	94,223	63.0	59,337	347,540	5.86
West Virginia	135	19,912	230	6,226,234	61.1	3,803,850	7,354,039	1.93
Indiana, Kansas, Maryland, Massachusetts, Michigan, Minnesota, Montana, New Jersey, New York, Oklahoma, Wisconsin	28	2,926	563	3,840,467	73.5	2,822,231	10,432,395	3.70
Total	578	104,440	2,567	63,088,327	66.1	41,708,810	99,742,701	2.39

[a] Includes the production of Utah.

[b] Production included with Colorado.

PRODUCTION IN PREVIOUS YEARS.

The Seventh United States Census (1850) reported that there were four coke-making establishments in the United States in that year, but did not mention the number of ovens in operation nor the quantity and value of the coke produced. Mr. John Fulton, of Johnstown, Pa., in his "Treatise on coke," states that in 1837 100 tons of pig iron were made with coke as fuel by F. H. Oliphant at the Fairchance furnace in Fayette County, Pa., and that in the same year coke was used for iron making at the Lonaconing furnace at Frostburg, Md. The Eighth and Ninth United States Censuses, like the Seventh, reported the number of coking establishments in the census years, but carefully avoided any statements as to production, and yet in 1875, according to Mr. James M. Swank, general manager of the American Iron & Steel Association, the quantity of iron made with coke exceeded that made with anthracite, the latter fuel having held the supremacy since 1855, when it surpassed charcoal. Since 1875 the use of anthracite for iron making has steadily given way to coke until at the present time little anthracite iron is made, and what little is made is with an admixture of coke.

The first record of the quantity of coke produced in the United States is contained in the report of the Tenth United States Census (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 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 Twelfth Census in 1890 the production of coke was a little more than three times that of the quantity reported in 1880, and amounted to 11,508,021 short tons. By 1900 it had almost doubled that of 1890, the production in that year being 20,533,348 short tons. In 1910 the production had more than doubled, being 41,708,810 short tons. During this period of 30 years there have been 8 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 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, 1880–1910, in short tons.

1880	3, 338, 300	1891	10, 352, 688	1901	21, 795, 883
1881	4, 113, 760	1892	12, 010, 829	1902	25, 401, 730
1882	4, 793, 321	1893	9, 477, 580	1903	25, 274, 281
1883	5, 464, 721	1894	9, 203, 632	1904	23, 661, 106
1884	4, 873, 805	1895	13, 333, 714	1905	32, 231, 129
1885	5, 106, 696	1896	11, 788, 773	1906	36, 401, 217
1886	6, 845, 369	1897	13, 288, 984	1907	40, 779, 564
1887	7, 611, 705	1898	16, 047, 209	1908	26, 033, 518
1888	8, 540, 030	1899	19, 668, 569	1909	39, 315, 065
1889	10, 258, 022	1900	20, 533, 348	1910	41, 708, 810
1890	11, 508, 021				

In the following table is presented a statement of the production in each State and Territory during the last five years with the increases in 1910 as compared with 1909. Among the States and Territories for which the statistics are published separately, there were only two—Georgia and West Virginia—in which the production in 1910 was less than in 1909. The total increase in production was 2,393,745 short tons, of which Pennsylvania contributed 1,410,082, or more than 55 per cent. Illinois had the second largest increase, 237,548 tons, this being due to the operations of the Koppers ovens by the United States Steel Corporation at Joliet, but, as stated in the report for 1909, the coke in this case is made from coal mined in West Virginia. The increase in the production of coke in Illinois from West Virginia coal is probably responsible in part at least for the decrease in the production of coke in West Virginia. The coal production of West Virginia increased in 1910 over 1909 while the production of coke decreased. If the coke made in other States from coal mined in West Virginia were credited to West Virginia, that State would also have shown an increased production in 1910. The largest percentage of increase in 1910 was made in Washington, with Ohio second and Tennessee third.

Quantity of coke produced in the United States, 1906–1910, by States and Territories, in short tons, with increase and decrease in 1910.

State or Territory.	1906	1907	1908	1909	1910	Increase (+) or decrease (−) in quantity of coke produced.	
						1909–10	Per cent.
Alabama	3,034,501	3,021,794	2,362,666	3,085,824	3,249,027	+ 163,203	+ 5.3
Colorado [a]	1,455,905	1,421,579	982,291	1,251,805	1,346,211	+ 94,406	+ 7.5
Georgia	70,280	74,934	39,422	46,385	43,814	− 2,571	− 5.5
Illinois	268,693	372,697	362,182	1,276,956	1,514,504	+ 237,548	+18.6
Kansas	1,698	6,274	2,497	....	(b)	(b)	(b)
Kentucky	74,064	(b)	(b)	46,371	53,857	+ 7,486	+16.1
Montana	38,182	(b)	(b)	(b)	(b)	(b)	(b)
New Mexico	147,747	265,125	274,565	373,967	401,646	+ 27,679	+ 7.4
Ohio	293,994	270,634	159,578	222,711	282,315	+ 59,604	+26.8
Oklahoma (Indian Territory)	49,782	(b)	(b)	....	(b)	(b)	(b)
Pennsylvania	23,060,511	26,513,214	15,511,634	24,905,525	26,315,607	+1,410,082	+ 5.7
Tennessee	483,428	467,499	214,528	261,808	322,756	+ 60,948	+23.3
Utah	(c)	(c)	(c)	(c)	(c)	(c)	(c)
Virginia	1,577,659	1,545,280	1,162,051	1,347,478	1,493,655	+ 146,177	+10.9
Washington	45,642	52,028	38,889	42,981	59,337	+ 16,356	+38.1
West Virginia	3,713,514	4,112,896	2,637,123	3,943,948	3,803,850	− 140,098	− 3.6
Other States	2,085,617	2,655,610	2,286,092	2,509,306	2,822,231	+ 312,925	+12.5
Total	36,401,217	40,779,564	26,033,518	39,315,065	41,708,810	+2,393,745	+ 6.1

[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 1910, inclusive:

Statistics of the manufacture of coke in the United States in 1880, 1890, and 1900–1910.

Year.	Establishments.	Ovens.		Coal used (short tons).	Coke produced (short tons).	Total value of coke at ovens.	Price 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
1910	578	104,440	2,567	63,088,327	41,708,810	99,742,701	2.39	66.1

VALUE OF COKE PRODUCED.

The total value of the coke produced in the United States in 1910 was $99,742,701, an increase as compared with 1909 of $9,777,218, or 10.9 per cent. As the quantity of coke produced showed a gain of only 6.1 per cent, it would appear that the business done in 1910 was more remunerative than that of the preceding year. A study of the statistics, however, shows the contrary, for whereas the value of the coke produced in 1910 was $9,777,218 more than the value reported for 1909, the coal-mining expenses were increased in still greater proportion, and the value of the coal charged into ovens, as reported to the Survey in 1910, showed an increase over 1909 of $12,643,011. This advance in the value of the coal used was nearly $3,000,000 more than the increase in the value of the coke. Prices at the beginning of the year were fairly good, but began declining before the first month had passed, and continued to decline until in December Connellsville coke was quoted at $1.40, a figure lower than the average annual prices since the panic year of 1894 and one at which coke can not be sold except at a loss. Naturally production fell off in the latter part of the year and less coke was sold at the lower prices than in the earlier months, when prices were better; consequently the effect upon the average price for the year was proportionately less. Moreover, most of the coke is sold on contracts made several months ahead of delivery and spot prices do not indicate the actual value of the coke marketed. The average price of the coke sold in 1910 was $2.39 per short ton, 10 cents more than the average for 1909. 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 1910 as compared with 1909, 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, 1906–1910, by States and Territories, with increase and decrease in 1910.

State or Territory.	1906	1907	1908	1909	1910	Increase (+) or decrease (−) in value of coke produced.	
						1909–10	Per cent.
Alabama	$8,477,899	$9,216,194	$7,169,901	$8,068,267	$9,165,821	+$1,097,554	+13.6
Colorado[a]	4,504,748	4,747,436	3,238,888	4,135,931	4,273,579	+ 137,648	+ 3.3
Georgia	277,921	315,371	137,524	159,334	173,049	+ 13,715	+ 8.6
Illinois	1,205,462	1,737,464	1,538,952	5,361,510	6,712,550	+1,351,040	+25.2
Kansas	4,101	19,837	8,011	....	(b)	(b)	(b)
Kentucky	169,846	(b)	(b)	101,257	120,554	+ 19,297	+19.1
Montana	266,024	(b)	(b)	(b)	(b)	(b)	(b)
New Mexico	442,712	840,253	826,780	1,099,694	1,306,136	+ 206,442	+18.8
Ohio	1,013,248	819,262	491,982	683,155	911,987	+ 228,832	+33.5
Oklahoma (Indian Territory)	204,205	(b)	(b)	....	(b)	(b)	(b)
Pennsylvania	54,184,531	67,638,024	32,569,621	50,377,035	55,254,599	+4,877,564	+ 9.7
Tennessee	1,350,856	1,592,225	561,789	667,723	959,104	+ 291,381	+43.6
Utah	(c)	(c)	(c)	(c)	(c)	(c)	(c)
Virginia	3,611,659	3,765,733	2,121,980	2,415,769	2,731,348	+ 315,579	+13.1
Washington	226,977	293,019	213,138	240,604	347,540	+ 106,936	+44.4
West Virginia	8,192,956	9,717,130	5,267,054	7,525,922	7,354,039	− 171,883	− 2.3
Other States	7,474,889	10,837,178	8,338,363	9,129,282	10,432,395	+1,303,113	+14.3
Total	91,608,034	111,539,126	62,483,983	89,965,483	99,742,701	+9,777,218	+10.9

[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, 1880–1910.

1880	$6, 631, 265	1891	$20, 393, 216	1902	$63, 339, 167
1881	7, 725, 175	1892	23, 536, 141	1903	66, 498, 664
1882	8, 462, 167	1893	16, 523, 714	1904	46, 144, 941
1883	8, 121, 607	1894	12, 328, 856	1905	72, 476, 196
1884	7, 242, 878	1895	19, 234, 319	1906	91, 608, 034
1885	7, 629, 118	1896	21, 660, 729	1907	111, 539, 126
1886	11, 153, 366	1897	22, 102, 514	1908	62, 483, 983
1887	15, 321, 116	1898	25, 586, 699	1909	89, 965, 483
1888	12, 445, 963	1899	34, 670, 417	1910	99, 742, 701
1899	16, 630, 301	1900	47, 443, 331		
1890	23, 215, 302	1901	44, 445, 923		

From the preceding statements, which show 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.

The average prices of coke, by States, from 1906 to 1910, inclusive, and for the United States from 1880 to 1910, are shown in the following tables:

Average price per short ton, at the ovens, of the coke made in the United States, 1906–1910, by States and Territories.

State or Territory.	1906	1907	1908	1909	1910
Alabama	$2. 79	$3. 05	$3. 04	$2. 61	$2. 82
Colorado [a]	3. 09	3. 34	3. 30	3. 30	3. 17
Georgia	3. 95	4. 21	3. 72	3. 44	3. 95
Illinois	4. 48	4. 66	4. 25	4. 20	4. 43
Kansas	2. 42	3. 16	3. 21	....	(b)
Kentucky	2. 29	2. 35	(b)	2. 18	2. 24
Montana	6. 97	7. 25	(b)	(b)	(b)
New Mexico	3. 00	3. 17	3. 01	2. 94	3. 25
Ohio	3. 45	3. 03	3. 08	3. 07	3. 23
Oklahoma (Indian Territory)	4. 10	4. 32	(b)	....	(b)
Pennsylvania	2. 35	2. 55	2. 10	2. 02	2. 10
Tennessee	2. 79	3. 41	2. 62	2. 55	2. 97
Utah	(c)	(c)	(c)	(c)	(c)
Virginia	2. 29	2. 44	1. 83	1. 79	1. 83
Washington	4. 97	5. 63	5. 48	5. 60	5. 86
West Virginia	2. 21	2. 36	2. 00	1. 99	1. 93
Other States	3. 58	4. 07	3. 65	3. 64	3. 70
Average	2. 52	2. 74	2. 40	2. 29	2. 39

[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, 1880-1910.

1880	$1.99	1891	$1.97	1901	$2.04
1881	1.88	1892	1.96	1902	2.49
1882	1.77	1893	1.74	1903	2.63
1883	1.49	1894	1.34	1904	1.95
1884	1.49	1895	1.44	1905	2.25
1885	1.49	1896	1.84	1906	2.52
1886	1.63	1897	1.66	1907	2.74
1887	2.01	1898	1.59	1908	2.40
1888	1.46	1899	1.76	1909	2.29
1889	1.62	1900	2.31	1910	2.39
1890	2.02				

NUMBER OF COKE WORKS AND OVENS IN THE UNITED STATES.

In compiling the statistics of coke manufacture each bank of ovens is considered as a separate establishment, although in many cases these different establishments form a part only of one property and are reported from a central office. Different plants controlled or operated by one company are considered as much separate establishments as are the individual banks of ovens owned and operated by one firm or corporation. During 1910 there were 9 coking establishments abandoned and dismantled, and 8 new establishments were completed, a net decrease of 1 in the number of establishments at the close of 1910 as compared with 1909. There were 578 establishments in existence at the close of 1910 against 579 at the close of 1909. Of the 9 establishments abandoned and dismantled in 1910, there was 1 each in Colorado, Montana, Oklahoma, and Virginia, 2 in Pennsylvania, and 3 in West Virginia. The total number of ovens dismantled was 894. In addition to the abandoned plants there were 100 establishments, or banks of ovens, that were idle during the entire year. These idle establishments represented a total of 8,373 ovens, or an average of a little more than 83 ovens to an establishment. The 478 active establishments represented a total of 96,067 ovens, or an average of 201 ovens for each plant, indicating that the majority of the idle establishments were relatively small plants. The 478 active establishments produced in 1910 41,708,810 tons of coke, or an average of 87,257 tons for each plant. In 1909 there were 474 active establishments, which produced 39,315,065 tons, or an average of 82,943 tons for each establishment. As an indication as to how the coking industry, like many others, has become concentrated into large units, a comparison of the statistics for 1880, the first year for which information of this kind was collected, shows that in that year there were 186 establishments, which produced a total of 3,338,300 tons of coke, or an average of 17,948 tons to an establishment. In 1880 there were 12,372 ovens in existence, an average of 67 to the establishment, as compared with an average of 201 for the number of ovens to each active establishment in 1910. The average size of each plant in 1910 was three times the average in 1880, while the average production has increased nearly five times. 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 1910, 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	1901, December 31	423	1906, December 31	532
1860 (census year)	21	1902, December 31	456	1907, December 31	552
1870 (census year)	25	1903, December 31	500	1908, December 31	551
1880, December 31	186	1904, December 31	506	1909, December 31	579
1890, December 31	253	1905, December 31	519	1910, December 31	578
1900, December 31	396				

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 1910—104,440—was 11 per cent more than in 1906, 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, 1906–1910.

State or Territory.	1906	1907	1908	1909	1910
Alabama	9,731	9,889	10,103	10,061	10,132
Colorado	3,419	3,799	3,841	3,846	3,611
Georgia	531	350	350	350	350
Illinois	309	309	430	468	508
Indiana	48	28	46	96	90
Kansas	81	83	67	67	71
Kentucky	462	495	495	494	495
Maryland	200	200	200	200	200
Massachusetts	400	400	400	400	400
Michigan	150	150	150	162	162
Minnesota	50	50	50	50	50
Missouri	6	5	4	4	4
Montana	555	567	551	551	451
New Jersey	150	150	150	150	150
New Mexico	571	896	1,016	1,030	1,030
New York	540	540	540	556	556
Ohio	575	600	481	447	496
Oklahoma (Indian Territory)	490	490	486	536	408
Pennsylvania	47,185	51,364	52,606	54,506	55,656
Tennessee	2,731	2,806	2,792	2,729	2,792
Utah	684	884	864	854	854
Virginia	4,641	5,333	4,853	5,469	5,389
Washington	216	216	231	285	285
West Virginia	19,714	19,688	20,124	20,283	19,912
Wisconsin	388	388	388	388	388
Wyoming	74	0	0	0	0
Total	93,901	99,680	101,218	103,982	104,440

Number of coke ovens in the United States on December 31 of each fifth year, from 1880 to 1910.

1880	12,372	1900	58,484
1885	20,116	1905	87,564
1890	37,158	1910	104,440
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 by this to show 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, 1906–1910.

1905	4,751	1908	2,241
1906	4,519	1909	2,950
1907	2,546	1910	2,567

RANK OF COKE-PRODUCING STATES.

The only change in the rank of the important coke-producing States in 1910 was the superseding in fourth place of Virginia by Illinois, the advancement of the latter State being due to the operations of the Semet-Solvay retort ovens at South Chicago and of the 280 Koppers ovens of the Illinois Steel Co. at Joliet. In 1906 Illinois ranked fourteenth among the coke-producing States; rose to tenth place in 1907, to ninth in 1908, to fifth in 1909, and took fourth place in 1910. It should be stated, however, that the coal for the Illinois retort ovens is obtained from the mines of West Virginia, and the coke product might justly be credited to the latter State. Ohio changed places with New Jersey in 1910—fourteenth and fifteenth, respectively—and Indiana advanced from twenty-second to seventeenth place. It is probable that in 1911, or certainly in 1912, Indiana will rank among the first six in the manufacture of coke, because of the construction of 560 Koppers by-product ovens by the Illinois Steel Corporation at Gary. The work on these ovens was begun in 1909, but was not completed at the close of 1910. In the quantity of coke produced West Virginia ranked second and Alabama third, these relative positions having been maintained during the last six years. In 1910 West Virginia produced 550,000 tons more than Alabama, but in the value of the product Alabama led West Virginia by a wide margin. In 1910 the value of the coke made in Alabama exceeded that of West Virginia by over $1,800,000. This condition is due to the advantage possessed by Alabama in the local markets for her product. Practically all of the coke made in Alabama is consumed in the furnaces of Birmingham and vicinity, whereas almost the entire coke output of West Virginia is shipped to competitive markets in other States. The average quality of West Virginia coke is superior to that of Alabama, yet the average price for Alabama coke in 1910 was higher by 89 cents, or nearly 50 per cent, than that of the West Virginia product, the figures being, respectively, $2.82 and $1.93.

Rank of the States and Territories in production of coke, 1906–1910.

State or Territory.	1906	1907	1908	1909	1910
Pennsylvania	1	1	1	1	1
West Virginia	2	2	2	2	2
Alabama	3	3	3	3	3
Illinois	14	10	9	5	4
Virginia	4	4	4	4	5
Colorado	5	5	5	6	6
New York	8	6	6	7	7
Wisconsin	13	7	8	8	8
Massachusetts	7	9	7	9	9
New Mexico	16	15	10	10	10
Michigan	11	13	13	11	11
Maryland	9	11	11	12	12
Tennessee	6	8	14	13	13
Ohio	12	14	15	15	14
New Jersey	15	16	12	14	15
Utah	10	12	16	16	16
Indiana	....	....	24	22	17
Minnesota	17	17	17	17	18
Washington	21	20	19	20	19
Kentucky	18	19	20	19	20
Georgia	19	18	18	18	21
Montana	22	21	21	21	22
Oklahoma	20	22	22	....	23
Kansas	23	23	23	....	24
Wyoming	24	....	....	....	....

COAL CONSUMED IN THE MANUFACTURE OF COKE.

As 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, a considerable quantity of the coal so used being 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 previously 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 1910 was 63,088,327 short tons, against 59,354,937 so used in 1909, an increase of 3,733,390 tons, or 6.29 per cent.

The quantity of coal used in the manufacture of coke, as obtained for this report from the several States and Territories, from 1906 to 1910 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, 1906–1910, by States and Territories, in short tons.

State or Territory.	1906	1907	1908	1909	1910
Alabama	5,184,597	4,973,296	3,875,791	5,080,764	5,272,322
Colorado [a]	2,566,196	2,388,911	1,546,044	1,984,985	2,069,266
Georgia	128,052	136,031	71,452	86,290	80,019
Illinois	362,163	514,983	503,359	1,682,122	1,972,955
Kansas	2,807	11,392	3,790	0	(b)
Kentucky	148,448	129,538	(b)	89,083	104,103
Montana	69,045	68,948	(b)	(b)	(b)
New Mexico	261,609	446,140	454,873	694,390	651,494
Ohio	437,567	376,759	237,448	340,735	413,059
Oklahoma (Indian Territory)	95,296	38,615	(b)	0	(b)
Pennsylvania	34,503,513	39,733,177	23,215,964	36,983,568	39,455,785
Tennessee	929,405	825,221	395,936	493,283	597,658
Utah	(c)	(c)	(c)	(c)	(c)
Virginia	2,296,227	2,264,720	1,785,281	2,060,518	2,310,742
Washington	76,896	85,860	68,069	69,708	94,223
West Virginia	5,822,619	6,536,795	4,127,730	6,361,759	6,226,234
Other States	2,861,934	3,415,723	3,155,100	3,427,732	3,840,467
Total	55,746,374	61,946,109	39,440,837	59,354,937	63,088,327

[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, 1880–1910.

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	1910	63,088,327
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 1909 and 1910, with the quantity and value of the coal consumed per ton of coke produced, by States and Territories, are shown in the following tables:

Quantity and value of coal used in the manufacture of coke in the United States in 1909 and 1910, and quantity and value of same per ton of coke, by States and Territories.

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	5,080,764	$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	104,899	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	3,427,732	7,958,196	2.32	1.366	3.169
Total	59,354,937	62,203,382	1.05	1.510	1.586

[a] Includes Utah.

Quantity and value of coal used in the manufacture of coke in the United States in 1909 and 1910, and quantity and value of same per ton of coke, by States and Territories—Contd.

1910.

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	5,272,322	$7,293,661	$1.38	1.623	$2.240
Colorado [a]	2,069,266	2,573,729	1.24	1.537	1.906
Georgia	80,019	103,605	1.29	1.826	2.356
Illinois	1,972,955	5,257,838	2.66	1.303	3.466
Kentucky	104,103	45,259	.43	1.933	.832
New Mexico	651,494	952,252	1.46	1.622	2.368
Ohio	413,059	784,713	1.90	1.463	2.780
Pennsylvania	39,455,785	40,667,042	1.03	1.499	1.544
Tennessee	597,658	740,598	1.24	1.852	2.296
Virginia	2,310,742	2,029,751	.88	1.547	1.361
Washington	94,223	249,680	2.65	1.588	4.208
West Virginia	6,226,234	5,097,073	.82	1.637	1.342
Other States [b]	3,840,467	9,051,192	2.35	1.361	3.198
Total	63,088,327	74,846,393	1.19	1.513	1.800

[a] Includes Utah.
[b] Includes Indiana, Kansas, Maryland, Massachusetts, Michigan, Minnesota, Montana, New Jersey, New York, Oklahoma, and Wisconsin.

The total quantity of coal consumed in the manufacture of coke in 1910 amounted to 63,088,327 short tons, a gain of 3,733,390 tons, or 6.29 per cent, over the quantity reported for 1909 of 59,354,937 tons. The value, however, increased from $62,203,382 in 1909 to $74,846,393, a gain of $12,643,011, or 20.33 per cent. It will be seen from a study of these statistics that the increase in the value of the coal used was considerably more than the increase in the coke product, this being attributable primarily to the increased cost of labor. The average value per ton for the coal used rose from $1.05 to $1.19, a difference of 14 cents per ton, whereas the value of the coke product increased only 10 cents per ton. It must be remembered, however, in considering these values, that the fixing of them is necessarily an arbitrary matter and they can not be said to represent actual market conditions.

The following table shows approximately the quantity of coal, given 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 up to 1910, the lowest figure, 3,020 pounds, being reported 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	1905	1.537	3,074
1890	1.56	3,120	1906	1.531	3,062
1900	1.57	3,140	1907	1.519	3,038
1901	1.57	3,140	1908	1.515	3,030
1902	1.56	3,120	1909	1.510	3,020
1903	1.56	3,120	1910	1.513	3,026
1904	1.544	3,088			

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 will continue to grow. An unimportant exception in this is to be noted in the yield for 1910, which shows a decrease of 0.1 per cent as compared with 1909. This is due to the relatively large increase in Pennsylvania's production, whose percentage yield of coal in coke decreased from 67.3 in 1909 to 66.7 in 1910. In 1880, before any retort-oven coke was made in the United States, the percentage yield of coal in coke was 63; in 1910 it was 66.1. In retort-oven practice the quantity of coal consumed in the ovens is usually accurately determined and amounted in 1910 to 9,529,042 tons, yielding 7,138,734 tons of coke, an average yield of coal in coke of 74.9 per cent. Deducting the output of the retort ovens from the total output leaves 53,559,285 tons of coal consumed in beehive ovens, which yielded 34,570,076 tons of coke, or an average yield of 64.6 per cent.

As previously stated, it is not always possible to obtain definite information as to the actual quantity of coal charged into the ovens, as the coal is not always weighed before charging and the quantity is therefore largely a matter of estimate, this estimate being 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 practice, and also in the keeping of records. For this reason the figures show 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, 1906–1910, by States and Territories.

State or Territory.	1906	1907	1908	1909	1910
Alabama	58.5	61.0	61.0	60.7	61.6
Colorado[a]	56.7	59.5	63.5	63.1	65.1
Georgia	54.9	55.1	55.2	53.8	54.8
Illinois	74.2	72.3	72.0	75.9	76.8
Indiana	....	....	70.0	44.4	78.3
Kansas	60.5	55.0	65.9	....	75.2
Kentucky	49.9	51.7	50.0	52.0	51.7
Montana	55.3	59.0	58.3	44.7	44.7
New Mexico	56.5	59.4	60.4	53.9	61.6
Ohio	67.2	71.8	67.2	65.4	68.3
Oklahoma (Indian Territory)	52.2	49.4	46.0	....	45.0
Pennsylvania	66.8	66.7	66.8	67.3	66.7
Tennessee	52.0	56.6	54.2	53.1	54.0
Virginia	68.7	68.2	65.1	65.4	64.6
Washington	59.4	60.6	57.1	61.7	63.0
West Virginia	63.8	62.9	63.9	62.0	61.1
Maryland	72.9 (Maryland to Wyoming)	73.0	72.1	67.9	65.6
Massachusetts		75.0	76.4	77.7	77.3
Michigan		77.0	74.5	74.1	75.7
Minnesota		68.0	66.4	67.7	68.0
New Jersey		80.0	72.3	77.7	76.1
New York		72.0	71.3	72.0	71.7
Wisconsin		74.0	74.5	76.1	77.4
Wyoming		....	....	....	....
Total average	65.3	65.8	66.0	66.2	66.1

[a] Includes Utah.

Percentage yield of coal in coke, 1880–1910.

1880	63.0	1903	64.1	1907	65.8
1890	64.0	1904	64.8	1908	66.0
1900	63.9	1905	65.1	1909	66.2
1901	63.7	1906	65.3	1910	66.1
1902	64.1				

CONDITION IN WHICH COAL IS CHARGED INTO THE OVENS.

In the following table is to be found a statement of the condition in which the coal is charged into the ovens in the several States and Territories for the last two years and for each of the five-year periods since 1890. In a number of the coking districts the princpial oven fuel is the slack coal produced in the mining operations. By far the larger quantity, however, is run-of-mine, some of which is crushed before being charged into the ovens, as in many cases it is found that a better and more uniform quality of coke is obtained when the coal is crushed before coking. Considerable quantities of both mine-run and slack coal are washed before being coked in order to remove the impurities consisting of slate, pyrite, etc. In 1910 21.7 per cent of all the coal charged into the coke ovens was washed and 78.3 per cent was used without other preparation than in some instances crushing. The mine-run coal that is crushed before coking is considered as mine-run coal and not as slack.

A comparison with earlier years shows that in 1890 only 7 per cent of the total quantity of coal used, or 1,269,810 short tons, was washed before being coked. According to the following table a much larger percentage of the slack used is washed than of the run-of-mine coal used. In 1910 there were 6,842,078 short tons of slack coal used unwashed, and 8,513,010 tons washed; in the run-of-mine coal there were 42,554,324 tons unwashed and 5,178,915 tons washed. 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 86.1 per cent and West Virginia 89.2 per cent. In Illinois practically the entire amount used is unwashed and in Virginia all of the coal used for coking is unwashed. In New Mexico and Washington, on the other hand, all of the coal is washed before being coked; in Alabama 85.4 per cent, in Georgia 97.7 per cent, in Tennessee 93 per cent, and in Kentucky 82.4 per cent was washed before being charged into the ovens.

The following tables show the quantity of run-of-mine and of slack coal, unwashed and washed, charged into the ovens in 1909 and 1910, by States, with the percentage of each:

Character of coal used in the manufacture of coke, by States and Territories, in 1909 and 1910, in short tons.

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, Montana, New Jersey, New York, Wisconsin	2,358,000	32,215	1,002,817	34,700	3,360,817	98.0	66,915	2.0
Total	40,594,842	6,007,760	6,926,484	5,825,851	47,521,326	80.1	11,833,611	19.9

1910.

State or Territory.	Run-of-mine.		Slack.		Total.			
	Unwashed.	Washed.	Unwashed.	Washed.	Unwashed.	Percentage.	Washed.	Percentage.
Alabama	771,931	1,308,085	0	3,192,306	771,931	14.6	4,500,391	85.4
Colorado [a]	252,468	836,067	429,728	551,003	682,196	33.0	1,387,070	67.0
Georgia	1,811	0	0	78,208	1,811	2.3	78,208	97.7
Illinois	1,971,386	0	0	1,569	1,971,386	99.9	1,569	0.1
Kentucky	17,695	0	620	85,788	18,315	17.6	85,788	82.4
New Mexico	0	0	0	651,494	0	....	651,494	100.0
Ohio	333,397	0	12,212	67,450	345,609	83.7	67,450	16.3
Pennsylvania	32,688,029	2,372,115	1,275,348	3,120,293	33,963,377	86.1	5,492,408	13.9
Tennessee	41,650	346,769	0	209,239	41,650	7.0	556,008	93.0
Virginia	1,554,784	0	755,958	0	2,310,742	100.0	0	....
Washington	0	3,361	0	90,862	0	....	94,223	100.0
West Virginia	2,088,553	234,484	3,462,927	440,270	5,551,480	89.2	674,754	10.8
Indiana, Kansas, Maryland, Massachusetts, Michigan, Minnesota, Montana, New Jersey, New York, Oklahoma, Wisconsin	2,832,620	78,034	905,285	24,528	3,737,905	97.3	102,562	2.7
Total	42,554,324	5,178,915	6,842,078	8,513,010	49,396,402	78.3	13,691,925	21.7

[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 1910:

Character of coal used in the manufacture of coke in the United States, 1890–1910, in short tons.

Years.	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
1910	42,554,324	5,178,915	6,842,078	8,513,010	63,088,327

COKE MAKING IN BY-PRODUCT OVENS.

During 1909 and 1910 there was more activity in the construction of by-product recovery coking plants than at any time since 1903. At the close of 1909 there were 649 by-product ovens in course of construction, with 300 more contracted for. Of the 649 ovens under construction in 1909, 99 were completed and put in blast in 1910. Work on the 300 ovens contracted for in 1909 was begun in 1910. These are Didier ovens and are being built by the Lehigh Coke Co. at South Bethlehem, Pa. The 560 Koppers ovens mentioned in the report for 1909 as under construction for the United States Steel Corporation at Gary, Ind., were not completed at the close of 1910. In addition to these the Woodward Iron Co. began the construction of 60 Koppers ovens at Woodward, Ala., and the Tennessee Coal, Iron & Railroad Co. began the construction of 280 Koppers ovens at Corey, Ala., making a total of 1,200 by-product ovens building at the close of 1910. The total number of completed by-product ovens in 1910 was 4,078, all but 27 of which were in active operation during 1910, against 3,914 in 1909 and 3,679 in 1908. The production of coke in by-product ovens in 1910 amounted to 7,138,734 short tons, against 6,254,644 tons in 1909 and 4,201,226 tons in 1908. The increase in 1910 over 1909 was 884,090 tons, or 14.13 per cent, whereas the total production of beehive coke increased from 33,060,421 short tons to 34,570,076 tons, a gain of 1,509,655 tons, or 4.57 per cent. The coke made in by-product ovens in 1910 was 17.12 per cent of the total production. In 1909, 15.91 per cent of the total was by-product coke.

The average production from each of the 4,051 active by-product ovens in 1910 was 1,762 short tons of coke, as compared with 1,598 tons per oven in 1909, and 1,142 tons per oven in 1908. The average production for each beehive oven in 1910 was 376 tons, against an average of 361 tons in 1909 and 258 tons in 1908. The average production of the by-product ovens in 1910 was nearly five times the average output of beehive ovens. The average value of the yield from the retort ovens, including the value of the by-products in 1910, was $8,213 per oven. The average value of the coke produced from each beehive oven was $815, the yearly yield in value for each retort oven being more than ten times that obtained from the beehive ovens. The quantity of coal consumed in the manufacture of coke and by-products in retorts in 1910 was 9,529,042 short tons, yielding 7,138,734 tons of coke, or an average yield of coal in coke of 74.9 per cent. In 1909 the average coke yield in the by-product ovens was 74.5 per cent, and in 1908 it was 73.7 per cent. This is a much higher yield than that obtained in the beehive ovens, where the process is one of combustion, not of distillation, as in the retort oven. It is impossible to make coke in the beehive oven without consuming a portion of the fixed carbon, and in 1910 the average yield of coal in coke in the beehive oven was 64.6 per cent, the difference in favor of the retort oven being 10.3 points, or 16 per cent. The value of the 9,529,042 short tons of coal consumed in the retort ovens in 1910 was $20,797,344, an average of $2.18 per ton. The quantity of coal consumed in the beehive ovens was 53,559,285 short tons, valued at $54,049,049, or an average of

$1.01 per ton, the difference in these values being due to the fact that in beehive practice the transportation charges are borne by the coke, and as retort-oven plants are located at a distance from the mines, the freight charges are added to the value of the coal used.

The value of the 7,138,734 short tons of coke made in by-product ovens in 1910 was $24,793,016, an average of $3.47 per ton. The quantity of coke produced in beehive ovens was 34,570,076 short tons, valued at $74,949,685, or $2.17 per ton. If, however, the expense of transportation on beehive coke from the ovens to the points of consumption be added to the value of the coke it will probably be found that the cost of the beehive coke at the furnace has exceeded that of the retort-oven coke.

The total value of the by-products obtained from the manufacture of coke in retort ovens in 1910 was $8,479,557, or a little more than one-third of the value of the coke produced. In 1909 the value of the by-products amounted to $8,073,948, and in 1908 the value of the by-products recovered was $7,382,299. The value of the by-products recovered in 1910 consisted of 27,692,858 thousand cubic feet of surplus gas valued at $3,017,908; 66,303,214 gallons of tar, valued at $1,599,453; 70,247,543 pounds of ammonium sulphate or its equivalent, valued at $1,841,062; 20,229,421 pounds of anhydrous ammonia, valued at $1,725,266, and 4,654,282 gallons of ammonia liquor (the strength of which was not reported), valued at $295,868. In 1909, when the statistics of coke manufacture were collected through a cooperative arrangement with the Bureau of the Census "other products" consisting of light and secondary oil and small quantities of coke breeze, etc., were reported with a value of $380,355. These were not included in the figures for 1910, when this item would probably have shown a value of about $400,000. The value of the recoverable contents of the coal made into coke in beehive ovens which are wasted would, at the prices obtaining in 1910, have been worth between thirty-five and forty millions of dollars.

In the report for 1909 mention was made of the retort ovens recently constructed at Las Esperanzas, Mexico, and it was stated in that report that these were Belgian ovens. The writer is advised by Mr. Edwin Ludlow, formerly general manager of the Mexican Coal & Coke Co. that these ovens are Koppers regenerative ovens without by-product recovery. The gas, however, over and above that required for the regeneration of the ovens, was utilized in the generation of power, and whereas it was first estimated that each oven would produce 15 horsepower per hour, actual practice has shown that each oven produced about 20 horsepower per hour. If all of the coke made in the United States were produced in retort ovens, it is probable that not more than half of the number of ovens would be required, or, say, 45,000 ovens for 1910. These would yield, without by-product recovery, approximately 1,000,000 horsepower per hour for every day in the year.

The total value of the coke, gas, tar, ammonia, and other products produced at by-product recovery ovens during the last three years is shown in the table following.

Value of products obtained in manufacture of coke in retort ovens in 1908, 1909, and 1910.

	1908		1909		1910	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Gas..............M cubic feet..	16,205,925	$2,557,483	15,791,220	$2,609,211	27,692,858	$3,017,908
Tar....................gallons..	42,720,609	1,007,613	60,126,006	1,408,611	66,303,214	1,599,453
Ammonia, sulphate or reduced to equivalent in sulphate, pounds..........................	43,329,426	1,286,224	123,111,197	3,227,316	70,247,543	1,841,062
Ammonia liquor.......gallons..	....	....	....	....	4,654,282	295,868
Anhydrous ammonia.pounds..	15,445,030	2,530,979	4,871,014	448,455	20,229,421	1,725,266
All other products............	....	....	....	380,355	....	....
Total value of by-products	....	7,382,299	....	8,073,948	....	8,479,557
Coke...............short tons..	4,201,226	14,465,429	6,254,644	20,434,689	7,138,734	24,793,016
Grand total..............	....	21,847,728	....	28,508,637	....	33,272,573

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 some cases where the surplus gas is consumed by the producing or an affiliated company both the quantity and the value of the surplus gas become a matter of estimate, but the figures as presented are believed to be sufficiently accurate for statistical purposes. The value is usually placed at 10 to 15 cents per 1,000 cubic feet. The relatively lower value of the gas produced in 1910 as compared with the preceding years is due largely to the operations of the Koppers ovens at Joliet which yield a large quantity of surplus gas, and the gas is delivered to the United States Steel Corporation at a low valuation. The first plant of by-product ovens installed in the United States 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 Co.; 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 12 years ago, but was never operated. These ovens were afterward torn down and rebuilt at Pocahontas, Va., in 1900, but have not been in blast except for a short time immediately after completion. In 1906 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 Co. 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 Co., 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 evident 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. These ovens were not completed at the end of 1910. There were 50 United-Otto ovens completed and put in blast by the Citizens Gas Co. at Indianapolis, Ind., during 1910, and the 49 Semet-Solvay ovens building at Cleveland, Ohio, during 1909 were also completed and operated during 1910. These ovens were constructed from the 80 Rothberg ovens operated by the Cleveland Furnace Co. The Didier-March Co., of New York, began in 1910 the construction of 300 Didier by-product ovens at South Bethlehem, Pa. These ovens when completed will be operated by the Lehigh Coke Co. Other new work in 1910 consisted of 60 Koppers regenerative ovens being built by the Woodward Iron Co. at Woodward, Ala., and 280 Koppers ovens by the Tennessee Coal, Iron & Railroad Co. at Corey, Ala. Altogether, at the close of 1910 there were 4,078 by-product ovens in existence and 1,200 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, 1893–1910.

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	3,989	949	6,254,644
1901	1,165	1,533	1,179,900	1910	[a] 4,078	[b] 1,200	7,138,734

[a] Includes 1,387 Semet-Solvay, 2,104 United-Otto, 307 Rothberg, and 280 Koppers ovens.
[b] Includes 900 Koppers and 300 Didier ovens.

In the following table is shown the record of by-product coke ovens, by States, at the close of 1906–1910:

Record of by-product ovens, by States, 1906–1910.

State.	Dec. 31, 1906.		Dec. 31, 1907.		Dec. 31, 1908.		Dec. 31, 1909.		Dec. 31, 1910.	
	Built.	Building.	Built.	Building.	Built.	Building.	Built.	Building.	Built.	Building.
Alabama	280	0	280	0	280	0	280	0	280	340
Illinois	160	0	160	280	300	140	440	40	480	0
Indiana	0	0	0	0	0	50	50	560	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	150	0	150	0	150	0	162	0	162	0
Minnesota	50	0	50	0	50	0	50	0	50	0
New Jersey	150	0	150	0	150	0	150	0	150	0
New York	540	0	540	0	540	0	556	0	556	0
Ohio	130	0	155	50	155	50	125	49	174	0
Pennsylvania	1,207	112	1,319	0	1,294	0	1,296	[a] 300	1,296	300
West Virginia	120	0	120	0	120	0	120	0	120	0
Wisconsin	160	0	160	0	160	0	160	0	160	0
Total	3,547	112	3,684	330	3,799	240	3,989	949	4,078	1,200

[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 1910 is shown in the following table:

Kinds of by-product ovens built and building in the United States, by States, at the close of 1910.

State.	United-Otto.[a]	Semet-Solvay.	Roth-berg.	Koppers.	Total.	
	Built.	Built.	Built.	Built.	Built.	Building.
Alabama	0	280	0	0	280	[b] 340
Illinois	0	200	0	280	480	0
Indiana	50	0	0	0	50	[b] 560
Maryland	200	0	0	0	200	0
Massachusetts	400	0	0	0	400	0
Michigan	30	132	0	0	162	0
Minnesota	50	0	0	0	50	0
New Jersey	150	0	0	0	150	0
New York	188	86	282	0	556	0
Ohio	100	49	25	0	174	0
Pennsylvania	936	360	0	0	1,296	[c] 300
West Virginia	0	120	0	0	120	0
Wisconsin	0	160	0	0	160	0
Total	2,104	1,387	307	280	4,078	1,200

[a] Includes the Otto-Hoffmann and Schniewind types. [b] Koppers ovens. [c] Didier ovens.

The following table, 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. C. G. Atwater, of the United Coke & Gas Co., Whitehall Building, New York City, and by Mr. W. H. Blauvelt, of the Semet-Solvay Co., Syracuse, N. Y., and again by Mr. Colby for the present chapter.

This table shows, in addition to the number of ovens at each by-product coke-oven plant in the United States, 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, January 1, 1911.

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.
Ala.	Ensley (near Birmingham).	Semet-Solvay	Tennessee Coal, Iron & R. R. Co.	First	Oct., 1898	120	Blast furnace	Fuel gas	
				Second	Mar., 1902	120	do	do	
	Tuscaloosa	do	Central Iron & Coal Co.	First	Feb., 1906	40	do	do	
	Woodward	Koppers	Woodward Iron Co.	dc	Began construction 1910.	60	do	Fuel and power	
	Corey	do	Tennessee Coal, Iron & R. R. Co.	do	do	280	do	do	
Ill.	Joliet	do	Illinois Steel Co.	do	Completed in 1908.	140	do	do	
	do	do	do	Second	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	1910.	40			
Ind.	Gary	Koppers	Illinois Steel Co.	First	Not completed.	560	Blast furnace		
	Indianapolis	United-Otto	Citizens Gas Co.	do	Completed 1909.	50	Blast furnace and foundry.	Illuminating gas for Indianapolis.	
Md.	Sparrows Point	do	Maryland Steel Co.	do	Mar., 1903	200	Blast furnace	Illuminating gas for city of Baltimore, 11 miles distant; 4,000,000 cubic feet daily.	
Mass.	Everett	Otto-Hoffmann	New England Gas & Coke Co.	do	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.
Mich.	Delray	Semet-Solvay	The Solvay Process Co.	do	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.	

Complete list of by-product and retort coke-oven plants of the United States, January 1, 1911—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.
N. J.	Camden	Otto-Hoffmann	Camden Coke Co	First	About Jan., 1903.	100	Blast furnace	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	Foundry and domestic (domestic coke crushed and sized for sale).		
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 and 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	
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	Cleveland Furnace Co.	do	Oct., 1907	25	do	do	Plant closed down March, 1908.
	do	Semet-Solvay	do	Third	1910	49			Originally 80 Rothberg ovens, now operated by the Semet-Solvay Co.

Pa.	Dunbar	do	The Dunbar Furnace Co.	First	Aug., 1896	50	Blast furnace	Fuel gas	
				Second	July, 1903	60			
	Chester	do	The Philadelphia Suburban Gas & Electric Co.	First	Apr., 1904	40	Blast furnace	Illuminating	
	South Sharon	United-Otto	Carnegie Steel Co.	do	July, 1903	212	do	do	
	Glassport	Otto-Hoffmann	United Coke & Gas Co.	do	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.	do	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 & 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 & 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	
Wis.	Milwaukee	do	Milwaukee Coke & Gas Co.	First	Mar., 1904	80	Blast furnace, foundry, and domestic.	Illuminating	
	do	do	do	Second	Mar., 1906	80			

[a] Increased to.

[b] Contracted for, 188 completed.

NOTES.—1. Of the 14 plants of Semet-Solvay ovens in the United States, 2 are owned by the Solvay Process Co., and the other 12 are operated by the Semet-Solvay Co., 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.

IMPORTS AND EXPORTS.

IMPORTS.

The following table gives the quantity and value of coke imported and entered for consumption in the United States from 1905 to 1910, 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, 1905–1910, in short tons.

1905	203,142	$796,545	1908	147,427	$606,294
1906	147,819	570,150	1909	191,253	736,120
1907	135,968	596,366	1910	172,716	625,130

EXPORTS.

The quantity of coke exported from the United States increased each year from 1900 to 1907, but since that time it has alternately decreased and increased, the figures for 1910 being slightly lower than those reported for 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 1905, in short tons.

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
1907	979,652	3,206,793	1910	984,562	3,053,293

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 principally 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. The total value of the domestic coal tar obtained in 1910 amounted to $1,599,453, and the value of the coal-tar products imported into this country, including the duty paid, was $10,234,524. The values in all cases of imports are at point of shipment, and do not include ocean freights, commissions, and other expenses. Considering this factor it is probable that the consumer has paid about $14,000,000 for these importations. 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, 1905–1910.

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
1910			430,393	Free.	501,369	Free.	5,867,331	1,760,098

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
1910	594,252	118,849	962,232	Free.	8,355,577	1,878,947

PRODUCTION OF COKE BY STATES.

ALABAMA.

The most significant feature of the coke-making industry in Alabama, as in most of the coke-producing States in 1910, was the advance in values. The quantity of coke produced in 1910 was not materially larger than in 1909, the increase being 163,203 short tons, or 5.3 per cent, from 3,085,824 short tons to 3,249,027 short tons, but with the improved demand prices advanced from an average of $2.61 per ton in 1909 to $2.82 in 1910, and the total value increased from $8,068,267 to $9,165,821, a gain of $1,097,554, or 13.6 per cent. In quantity the production of coke in Alabama in 1910 was the largest ever made, but the value of the 1910 product was about $50,000 less than that of 1907.

Reference has been made in previous reports to the advantages possessed by Alabama in having in the iron-making district of Birmingham a home market for its output of coke. Until the last few years Alabama and West Virginia were close rivals for second place among the coke-producing States, Pennsylvania of course being first Since 1905 West Virginia has outstripped Alabama in the quantity of coke produced, and in 1910 made 3,803,850 short tons of coke as compared with 3,249,027 tons made in the Alabama ovens. Little of West Virginia's coke is, however, supplied to local markets. Probably 98 per cent is shipped out of the State to furnish fuel to distant iron furnaces. The effect is shown by comparisons that may be made between the values of Alabama and West Virginia cokes, for whereas the quantity of coke made in West Virginia in 1910 exceeded the Alabama product by 554,823 short tons, the value of Alabama's coke exceeded that of West Virginia by $1,811,782. The average price of Alabama coke in 1910 was $2.82; that of West Virginia was $1.93.

Of the total quantity of coke made in 1910 in Alabama, 557,148 short tons were produced in by-product retort ovens, of which there are two establishments, with a total of 280 ovens in the State. The quantity of coal used in the retort ovens was 769,212 short tons, indicating a yield of coal in coke of 72.4 per cent. The average yield in coke made by the beehive ovens was 59.8 per cent. During 1910 construction was begun on a bank of 60 Koppers by-product recovery ovens at Woodward by the Woodward Iron Co., and the Tennessee Coal, Iron & Railroad Co. began the construction of 280 ovens of the same type at Corey. These were the only new ovens under construction in the State at the close of the year.

There were 43 establishments in Alabama in 1910, the same number as in 1909. The total number of ovens increased from 10,061 in 1909 to 10,132 in 1910. These do not include the 340 Koppers ovens under construction at the close of 1910. Of the 43 establishments 5, with a total of 518 ovens, were idle during the entire year 1910. In 1909 there were 6 establishments with a total of 713 ovens idle throughout the year. The average production from the 9,614 ovens that were in operation in 1910 was 338 short tons; in 1909 the average production per oven was 330 tons.

The principal coal beds of Alabama which furnish the coal for coke making are the Pratt, the Mary Lee, and the Blue Creek, all of which are in the Warrior Basin, and the mining operations are in Jefferson, Walker, and Tuscaloosa counties. Some coking coal is also produced from the Buck or Blocton No. 1 bed, in Bibb County.

The production of coke in Alabama in 1880, 1890, 1900, and from 1906 to 1910 is shown in the following table:

Statistics of the manufacture of coke in Alabama, 1880–1910.

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
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	10,061	0	5,080,764	3,085,824	8,068,267	2.61	60.7
1910	43	[a]10,132	[b]340	5,272,322	3,249,027	9,165,821	2.82	61.6

[a] Includes 280 Semet-Solvay ovens. [b] Koppers by-product ovens.

About 60 per cent of the coal made into coke in Alabama in 1910 was washed slack. The total quantity of coal made into coke in 1910 was 5,272,322 short tons, of which 3,192,306 tons were washed slack. Of the other, 2,080,016 tons, 1,308,085 tons were run-of-mine coal crushed and washed before coking, and 771,931 tons were unwashed mine-run coal. The total quantity of washed coal used was 4,500,391 short tons, or 86 per cent of all the coal made into coke.

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, 1890–1910, 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
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
1910	771,931	1,308,085	0	3,192,306	5,272,322

COLORADO AND UTAH.

As there are but two establishments engaged in the manufacture of coke in Utah, and both of these are owned by one company, the statistics of production in that State are included with Colorado. The production of the two States in 1910 amounted to 1,346,211 short tons valued at $4,273,579, against 1,251,805 short tons, valued at $4,135,931 in 1909. The increase in 1910 over 1909 was 94,406 short tons, or 7.5 per cent in quantity, and $137,648, or 3.3 per cent in value. The smaller increase in value and the decline in the average price per ton, from $3.30 in 1909 to $3.17 in 1910, do not appear to be assignable to any particular cause, unless it be to the larger proportion of slack coal used in the ovens in the latter year. In 1910 nearly 50 per cent of the coal used for coke making was slack, whereas in 1909 the quantity of slack coal made into coke represented only 35 per cent of the total. Considerable quantities of the Colorado coke are made in ovens that form a part of establishments which include coal mining, coke making, and the manufacture of iron and steel, or the smelting and refining of precious and semiprecious metals. In these cases the placing of values on the coke product is simply a matter of bookkeeping.

All of the ovens in use in Colorado and Utah are of the beehive type. They are distributed among 18 establishments, 16 in Colorado and 2 in Utah. There were 235 ovens abandoned in 1910, reducing the total number from 4,700 to 4,465. Six of the 18 establishments (5 in Colorado and 1 in Utah) were idle throughout 1910. The 6 idle establishments represented a total of 666 ovens.

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, 1880–1910.

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
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
1910	18	4,465	0	2,069,266	1,346,211	4,273,579	3.17	65.1

Of the 2,069,266 short tons of coal used in 1910 for coke making in Colorado and Utah, 1,387,070 tons were cleaned by washing before being charged into the ovens. The washed coal included 836,067 short tons of mine-run and 551,003 tons of slack. The unwashed coal consisted of 429,728 tons of slack and 252,468 tons of run of mine.

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, 1890–1910.

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
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
1910	252,468	836,067	429,728	551,003	2,069,266

GEORGIA.

Two counties, Dade and Walker, in the extreme northwest corner of Georgia, contain the only coal in the State. Portions of each of these counties are underlain by the coal measures of the Appalachian coal fields. The Walden Basin of Tennessee crosses Dade County in Georgia, and extending southwestwardly becomes the Blount Mountain and Warrior Basins in Alabama. The Walker County deposit is an extension northeasterly of the Lookout Mountain Basin, a narrow outlying area that has its principal development in Etowah County, Ala. The coals of both basins are of coking quality, those of Dade County being confined to the Lookout formation. These are generally thinner than the principal coals of the overlying Walden formation. The production at the present time is chiefly from the coals of the Walden formation in the Lookout Mountain Basin.

The screened coal from the Walker County mines is in good demand as a steam fuel and for the bunker trade, so that only the slack or fine coal passing through the screen is available for coke making. Most of the impurities pass through with the slack, which necessitates washing of the slack before charging into the ovens. A considerable portion of the fixed carbon is burned off in the coking process, for whereas the mine-run coal has a high content in fixed carbon (80 per cent) the yield of coal in coke is less than 55 per cent. The small quantity of coke made in Dade County (the first in three years) was from mine-run coal.

The total quantity of coke produced in Georgia in 1910 was 43,814 short tons, a decrease of 2,571 tons, as compared with 1909, when the production amounted to 46,385 short tons. There was a decided improvement in prices, however, the average price per ton being \$3.95 in 1910 against \$3.44 in 1909, and notwithstanding the decrease in output the value showed an increase of \$13,715.

The production of coke in Georgia during each of the last three years has been only about 60 per cent of that produced in the three years next preceding. The cause for this decrease has been the withdrawal by the State of the convicts who were employed as coal miners under lease. Inability to secure, in the somewhat isolated districts, sufficient free labor to keep the coal mines up to capacity has resulted in a marked decrease in the production of coal and this has naturally reduced the quantity of slack available for coke making. The average output of coke in Georgia from 1905 to 1907 inclusive was 71,936 short tons; during the last three years the average production has amounted to 43,207 tons.

The statistics of the manufacture of coke in Georgia in 1880, 1890, 1900, and from 1906 to 1910 are shown in the following table:

Statistics of the manufacture of coke in Georgia, 1880–1910.

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
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
1910	2	350	0	80,019	43,814	173,049	3.95	54.8

ILLINOIS.

With an increase in production of 237,548 short tons in 1910 over 1909, the coke output of Illinois exceeded that of Virginia by over 20,000 short tons, and Illinois became fourth in rank among the coke-producing States. Illinois has attained this prominence in the manufacture of coke through the construction and operation of 200 Semet-Solvay by-product ovens at South Chicago, and of 280 Koppers regenerative ovens at Joliet. The first by-product oven installation in the State was 160 of the Semet-Solvay ovens in 1906. This plant was increased to 200 ovens in 1910. The first half of the Koppers plant at Joliet was completed in 1908, and the second half in 1909. As a result of these installations the production of coke in Illinois jumped from 362,182 short tons in 1908 to 1,276,956 tons in 1909 and to 1,514,504 tons in 1910. The value of the product increased from $1,538,952 in 1908 to $5,361,510 in 1909 and to $6,712,550 in 1910. The increase in production in 1910 over 1909 was 237,548 short tons, or 18.6 per cent, while the value increased $1,351,040, or 25.2 per cent. The average price per ton advanced from $4.20 to $4.43. The higher value of Illinois coke as compared with that of Pennsylvania, West Virginia, or Alabama, is due to the fact that the Illinois coke is made from coal mined in West Virginia, and to the first cost of the coal has been added the transportation charges from the mines to Chicago or Joliet. The coke, however, is made at the point of consumption and does not have to bear any freight charges. The higher yield of coal in coke when made in by-product ovens is shown by an average yield of 76.8 per cent of

West Virginia coal in coke at the Joliet and South Chicago ovens, whereas the average yield in the coke-making districts of West Virginia (all but 120 out of about 20,000 ovens being of the beehive type) was 61.1 per cent. As the yield of coal in coke in the by-product ovens indicates 25 per cent better returns in coke alone, as compared with the beehive ovens, it would seem that some changes in the West Virginia practice is desirable.

In addition to the production of coke at South Chicago and at Joliet a small quantity was made from Illinois coal in Belgian ovens at Equality in Gallatin County.

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, 1906–1910.

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.					
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	468	40	1,682,122	1,276,956	5,361,510	4.20	75.9
1910	5	[a] 508	0	1,972,955	1,514,504	6,712,550	4.43	76.8

[a] Includes 200 Semet-Solvay and 280 Koppers ovens.

INDIANA.

The only plant in Indiana manufacturing coke during 1910 was that of the Citizens Gas Co. at Indianapolis, this plant being composed of 50 United-Otto ovens. The 10 ovens at Black Creek, which produced a small amount of coke during 1909, were not in operation during 1910, nor were those of the Ayrshire Coal Co. at Ayrshire, the latter not having been in blast for several years. During 1909 the United States Steel Corporation began the construction of 560 Koppers regenerative by-product ovens at Gary, to be operated in connection with its new steel plant at that place. These were not completed at the close of 1910. The coal for these ovens will probably be drawn from the mines operated by a subsidiary company of the Steel Corporation in West Virginia, and when put in blast 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. In 1909 all of the plants were idle, but in 1910 the Pittsburg Zinc Co. resumed operations and produced a small amount of coke.

The statistics of the manufacture of coke in this State in 1880, 1890, 1900, and from 1905 to 1910 are shown in the following table:

Statistics of the manufacture of coke in Kansas, 1880–1910.

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
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
1910	6	71	0	(a)	(a)	(a)	(a)	(a)

[a] Included with other States having less than three producers.

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, the larger part of the coke made in Kentucky has been made in the western district. There are 6 establishments in the State, but 2 of them, with a total of 54 ovens, have been idle during the last two years. In 1909 and 1910 of the 4 active establishments in the State, 2, with a total of 266 ovens, are in the eastern district, and 2, with a total of 175 ovens, are in the western district. The production in 1910 amounted to 53,857 short tons, valued at $120,554, against 46,371 tons, valued at $101,257 in 1909, an increase in 1910 of 7,486 short tons, or 16.1 per cent, in quantity, and of $19,297, or 19.1 per cent, in value. The average price per ton advanced from $2.18 in 1909 to $2.24 in 1910. Most of the increase in 1910 was from the ovens in the western district. The quantity of coal used for coke-making in Kentucky in 1910 was 104,103 short tons, principally slack, and most of it 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, 1880–1910.

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
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
1910	6	495	0	104,103	53,857	120,554	2.24	51.7

[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 two small plants credited to the State during the last five years was abandoned in 1907, and the other plant has been idle since 1905.

The statistics of production for a series of years have been as follows:

Statistics of the manufacture of coke in Missouri, 1887–1910.

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
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
1910	1	4	0	0	0	0	0	0

MONTANA.

One plant consisting of 100 ovens was permanently abandoned in Montana during 1910, and 3 of the other 4 establishments were idle throughout the year. The one producing company had an aggregate of 239 ovens, against 212 belonging to the 3 idle plants. All of the Montana coke ovens are of the beehive type. All of the coal used in the manufacture of coke in Montana is run-of-mine, a small portion of which is washed before coking. The details of output have been included with other States having less than 3 producers.

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 1906:

Statistics of the manufacture of coke in Montana, 1884–1910.

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	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
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
1910	4	451	3	(a)	(a)	(a)	(a)	(a)

[a] Included with other States having less than three producers.

NEW MEXICO.

All of the coke made in New Mexico is from coal mined from the Raton field in Colfax County. This field is the southern part of the Raton Mesa coal region, which consists of the Raton field in New Mexico and the Trinidad field in Colorado. The coal measures are continuous, but the producing areas are separated by a high divide near the Colorado-New Mexico line. A bank of 50 ovens at Waldo, in Santa Fe County, has not been in operation for several years. Slack coal only is used in the manufacture of coke, and as over 25 per cent of the total output of the mines yielding coking coal goes into slack, an ample supply of fuel for the coke ovens is available. The 3 mines in Colfax County at which coke is made produced in 1910 about 2,600,000 short tons of coal, of which about 700,000 tons was slack. All of this was washed, yielding 651,494 tons of cleaned coal which was charged into the ovens.

New Mexico has developed notably as a coke producer in the last 5 years. From a production of less than 90,000 short tons in 1905, the output has increased regularly to 147,747 tons in 1906, to 265,125 tons in 1907, to 274,565 tons in 1908, to 373,967 tons in 1909, and to 401,646 tons in 1910. The increase in 1910 over 1909 was 27,679 short tons, or 7.4 per cent. The value increased $206,442, or 18.8 per cent, from $1,099,694 to $1,306,136, and the average price advanced from $2.94 per ton in 1909 to $3.25 in 1910. The yield of coal in coke shows an apparent increase from 53.9 per cent in 1909 to 61.6 per cent in 1910. As the yield in 1910 was, however, approximately the same as for several years preceding 1909, it is probable that the low yield in that year was due to the weight of the coal before washing being reported. In 1910 the weight of the coal after washing is considered.

The 4 establishments in the Territory include a total of 1,030 ovens, of which 50 were idle both in 1909 and 1910. There was no new construction in 1910 and none was in progress at the end of the year. All of the ovens in the Territory are of the beehive type except that of 570 ovens at Dawson 446, although of beehive type, are provided with underflues through which the gases distilled from the coal are conveyed to a large flue back of the ovens and thence to the power house. The heat obtained from the oven gases renders the use of other fuel in the power plant unnecessary. The power plant, in addition to furnishing power for the operation of the mines, for ventilation, electric haulage, the coal crusher, washery, etc., furnishes also steam heat to the offices, commissary, hotel, hospital, and theater, and electric light for the entire city of Dawson.

The statistics of production in 1882, 1890, 1900, and from 1906 to 1910 are shown in the following table:

Statistics of the manufacture of coke in New Mexico, 1882–1910.

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
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
1910	4	1,030	0	651,494	401,646	1,306,136	3.25	61.6

OHIO.

The coals of Ohio belong to the Appalachian province, and most of the beds are correlated with those of Pennsylvania and West Virginia to the east and southeast. But although the bituminous and semibituminous coals of Pennsylvania and West Virginia include the highest grade coking coals in the United States, and although those two States are the first and second in rank as coke producers, the coals seem to lose their coking qualities as the beds extend westward, and a large part of the coke made in Ohio is from coal brought from West Virginia to by-product retort ovens at Hamilton, near Cincinnati, and at Cleveland. On the other hand, some of the coal mined in Ohio is a good blast-furnace fuel in the raw state, and this obviates the necessity of coking. When used raw, however, the coal is usually mixed with coke.

Ohio ranks fourth among the States as a coal producer, but only fourteenth in the manufacture of coke, and until 1905, when the first installation of by-product ovens was put in operation, Ohio could lay claim to little importance as a producer of coke.

During 1910 the work of dismantling 80 Rothberg ovens by the Cleveland Furnace Co. and the construction of 49 Semet-Solvay ovens from the old material was completed, and the new ovens contributed nearly 20 per cent of the total output of the State. Nearly 40 per cent of the total output of the State was from the Otto-Hoffman plant at Hamilton. The 25 Rothberg ovens left standing at Cleveland were not in operation in 1910. The average yield of coal in coke in the retort ovens was 72 per cent. In the 322 beehive ovens that constituted the remainder of the coke-producing capacity of Ohio the yield of coal in coke was 64 per cent.

The total production of coke in Ohio in 1910 was 282,315 short tons, valued at $911,987. In quantity this was, with the exception of 1906, the largest production in the history of the State. The value of the product in 1910 was exceeded in two earlier years, 1905 and 1906. Compared with 1909, the production in 1910 showed an increase of 59,604 short tons, or 26.8 per cent, in quantity, and of $228,832, or 33.5 per cent, in value. The average price per ton advanced from $3.07 in 1909 to $3.23 in 1910. As in Illinois, the higher value of the coke made in Ohio, as compared with that of the neighboring States of Pennsylvania and West Virginia, is due to a large part of the coal being brought from the West Virginia mines and the transportation charges having been borne by the coal; the coke is made at or 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, 1880–1910.

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
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	447	49	340,735	222,711	683,155	3.07	65.4
1910	8	[a] 496	0	413,059	282,315	911,987	3.23	68.3

[a] Includes 25 Rothberg, 100 United-Otto, and 49 Semet-Solvay ovens.

The larger part of the coal used in coke making in Ohio is unwashed run of mine. In 1910 the coal charged into the ovens consisted of 333,397 tons of unwashed run of mine, 12,212 tons of unwashed slack, and 67,450 tons of washed slack.

The character of the coal used in the manufacture of coke in Ohio in 1890, 1900, and from 1906 to 1910 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
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
1910	333,397	0	12,212	67,450	413,059

OKLAHOMA.

There has been little success made in the various attempts to manufacture coke from Oklahoma coal. Of the 4 establishments credited to the State in 1910—1 plant, consisting of 80 ovens, having been permanently abandoned during the year—3 were idle, the only producing establishment being that of the San Bois Coal Co. The largest quantity of coke made in this State (then Indian Territory), was reported in 1905, when 54,781 short tons were produced. Since that time, however, the output has steadily decreased, there being no production in 1909 and but a small quantity in 1910. The details of the 1910 output are included among other States having less than 3 producers.

The following table gives the statistics of the manufacture of coke in Oklahoma (Indian Territory) in 1880, 1890, 1900, and from 1906 to 1910:

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
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
1910	4	408	0	(a)	(a)	(a)	(a)	(a)

[a] Included with other States having less than three producers.

PENNSYLVANIA.

In the manufacture of coke, as in the production of coal, Pennsylvania stands preeminently in the lead among the States. Relatively it stands higher as a coke than as a coal producer, for whereas the output of coal in Pennsylvania is equal to nearly half that of the entire United States that State contributes more than 60 per cent of the total coke production. Many of the numerous bituminous coal beds of Pennsylvania yield coal of good coking quality, but the chief source of supply is from that portion of the famous Pittsburg bed which lies in what is known as the Connellsville Basin, in Fayette and Westmoreland counties, and a portion of the same bed in what is known as the Lower Connellsville district, lying entirely in Fayette County, and separated from the Main Connellsville Basin or district by the Greensburg anticline. The two counties of Fayette and Westmoreland yield more than 10 per cent of the total coal production of the United States, and the two districts, the Connellsville and Lower Connellsville, produce nearly half of the total output of coke. Since the manufacture of iron with coke as a fuel became an industry in the United States the Connellsville district has been the principal coke producing region. The Lower Connellsville district was not opened up until 1900, and though now only a little more than 10 years of age, and not yet in its "teens," it claims distinction as the second coke producing district in the United States. The northern extremity of the Connellsville Basin is designated as the Upper Connellsville district. The combined output of the three districts, all in Fayette and Westmoreland counties, represents 75 per cent of the total production of the State.

The quantity of coke produced in Pennsylvania in 1910 was 26,315,607 short tons, valued at $55,254,599, against 24,905,525 short tons, valued at $50,377,035, in 1909. The increase in 1910 over 1909 was 1,410,082 short tons, or 5.66 per cent, in quantity, and $4,877,564, or 9.68 per cent, in value. In considering the larger relative gain in value, however, account must be taken of the fact that there was a still larger increase in the cost of mining coal and a consequent advance in the value of the coal charged into the ovens. In 1909 the value of the coal used in the manufacture of coke was $32,065,729; in 1910 it was $40,667,042, the increase in 1910 being $8,601,313. The value of the coke produced increased $4,877,564, showing that, outside of any increase in the cost of making coke, there was a difference against 1910 of $3,723,749. In 1909 the difference between the value of the coal used and the coke produced was $18,311,306; in 1910 the difference was $14,587,557.

The average price per ton advanced from $2.02 in 1909 to $2.10 in 1910, the average in 1910 being the same as it was in 1908. The advance of 8 cents per ton in the price of coke from 1909 to 1910 was only half of the increase in the value per ton of the coal used in coke making. In 1909 the value of the coal charged into the ovens was 87 cents per short ton; in 1910 it was $1.03, an advance of 16 cents per ton in 1910 over 1909 as compared with the advance of 8 cents per ton in the value of the coke. It is to be noted that the tendency in prices in 1910 was exactly the reverse of what it was in 1909. In the earlier year values showed an advancing tendency, the prices in January ranging—for Connellsville furnace coke—from $1.50 to $2 per ton, reaching as high as $2.75 to $3 in October, and closing at $2.60 to $2.90 in December. In January, 1910, the average price for Connellsville coke ranged from $2.50 to $2.75, according to whether the prices were on contract or for immediate delivery. There was a general falling off throughout the year until December, when Connellsville coke sold for as low as $1.40, and the high price quoted for the month was $1.80.

The total quantity of coal consumed in the manufacture of coke in Pennsylvania in 1910 was 39,455,785 short tons, and as the coke obtained from this amounted to 26,315,607 short tons, the average percentage yield of coal in coke was 66.7. In 1909 the quantity of coal used for coke making was 36,983,568 short tons, and the quantity of coke produced was 24,905,525 short tons, an average yield of 67.3 per cent.

In spite of the decreasing rate of production and the declining tendency in prices during 1910 there was considerable activity in the construction of new plants. The total number of ovens in the State was increased 1,150—from 54,506 in 1909 to 55,656 in 1910. The total number of establishments increased from 283 to 288, but there were 3 more establishments and 37 more ovens idle in 1910 than in 1909. In 1909 there were 25 establishments and 2,158 ovens idle throughout the year; in 1910 there were 28 establishments and 2,195 ovens idle throughout the year. At the close of 1910 there were 1,334 ovens in course of construction, and it is to be noted with satisfaction that of the 1,334 ovens in course of construction at the end of the year 300 were Didier by-product recovery ovens, being built by the Didier-March Co. for the Lehigh Coke Co. at South Bethlehem. There were also under construction 612 of the rectangular type without recovery of by-products or other utilization of the oven gases. These rectangular ovens differ from the beehive oven only in the shape of the oven, and not in the process of carbonization of the coal. This type of oven has had its greatest development in the Lower Connellsville district. Its chief advantage is that the coke chamber being long and narrow the coke may be pushed from the ovens in the same manner as from retort ovens, and not "drawn," as in the case of the beehive.

Of the 55,656 ovens in existence at the close of 1910, 1,296, or 2 per cent, were of the by-product recovery type. These latter produced in 1910 a total of 2,052,973 short tons of coke, an average of 1,584 tons of coke per oven and an average yield of coal in coke of 76.1 per cent. Deducting the idle ovens in 1910, there were 52,165 ovens of the nonrecovery type which made coke, an average of 465 tons of coke per oven and an average yield of coal in coke of 66 per cent. The total value of the retort oven coke was $5,881,640, or $2.86 per ton, and that of the beehive coke, including coke from rectangular or longitudinal ovens, was $49,372,959, or $2.03 per ton.

The statistics of the production of coke in Pennsylvania for the years 1880, 1890, 1900, and for the last 5 years are shown in the following table:

Statistics of the manufacture of coke in Pennsylvania, 1880–1910.

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
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	54.506	2,072	36,983,568	24,905,525	50,377,035	2.02	67.3
1910	288	a55,656	b1,334	39,455,785	26,315,607	55,254,599	2.10	66.7

a Includes 936 United Otto, 360 Semet-Solvay, 152 Newton-Chambers, and 2,306 rectangular ovens.
b Includes 612 rectangular and 300 Didier 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 39,455,785 short tons of coal used in 1910 for coke making in Pennsylvania 32,688,029 tons were unwashed mine run and 1,275,348 tons were unwashed slack. The washed coal used consisted of 2,372,115 short tons of mine run and 3,120,293 tons of slack.

The character of the coal used in the manufacture of coke in Pennsylvania in 1890, 1895, 1900, and from 1905 to 1910 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
1910	32,688,029	2,372,115	1,275,348	3,120,293	39,455,785

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 1910 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 Co. 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 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 1910 the only ones for which separate statistics are published are: Allegheny Mountain, Connellsville, Greensburg, Lower Connellsville, Pittsburg, Reynoldsville-Walston, and Upper Connellsville districts.

Coke production in Pennsylvania in 1909 and 1910, by districts.

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	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	24,422	370	17,581,899	11,769,758	23,379,149	1.99	66.9
Greensburg	7	1,751	246	1,443,394	926,568	1,816,029	1.97	64.2
Lower Connellsville	70	14,215	1,036	9,781,803	6,761,335	12,490,518	1.85	69.1
Pittsburg	11	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	2,915	0	1,282,756	863,769	1,525,011	1.77	67.3
Other districts	22	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

1910.

District.	Establishments.	Built.	Building.	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).
Allegheny Mountain	25	[a] 2,523	0	1,431,309	1,016,487	$2,533,826	$2.49	71.0
Allegheny Valley	2	52	0	0	0	0	0	0
Connellsville	118	[b] 24,481	[c] 206	17,205,615	11,459,601	23,121,556	2.02	66.6
Greensburg	6	1,940	[d] 100	1,503,241	953,188	2,009,093	2.11	63.4
Lower Connellsville	73	[e] 14,805	[f] 668	12,130,425	8,219,492	16,048,675	1.95	67.8
Pittsburg	13	[g] 3,734	0	3,388,964	2,151,889	5,313,119	2.47	63.5
Reynoldsville-Walston	9	2,781	0	1,483,645	870,046	1,972,927	2.27	58.7
Upper Connellsville	21	[h] 2,850	[i] 60	780,888	504,876	956,422	1.89	64.7
Other districts [j]	21	[k] 2,490	[l] 300	1,531,698	1,140,028	3,298,981	2.89	74.4
Total	288	55,656	1,334	39,455,785	26,315,607	55,254,599	2.10	66.7

[a] Includes 372 United-Otto and 152 Newton-Chambers ovens.
[b] Includes 110 Semet-Solvay and 630 rectangular ovens.
[c] Includes 52 rectangular ovens.
[d] Rectangular ovens.
[e] Includes 1,237 rectangular ovens.
[f] Includes 400 rectangular ovens.
[g] Includes 332 United-Otto and 310 rectangular ovens.
[h] Includes 129 rectangular ovens.
[i] Rectangular ovens.
[j] Includes the Broadtop, Clearfield-Center, Irwin, and Lebanon and Schuylkill Valleys districts.
[k] Includes 232 United-Otto and 250 Semet-Solvay ovens.
[l] Didier 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 1910.

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 1910 there were 24,481 completed ovens in the Connellsville district, against 24,422 at the close of 1909, an increase in 1910 of 59 ovens. There were 206 ovens building at the close of 1910. Of the 24,481 completed ovens less than 0.5 per cent are of the by-product recovery type. Retort coke making is represented in the Connellsville district by 110 Semet-Solvay ovens operated by the Dunbar Furnace Co. at Dunbar. A few rectangular or longitudinal ovens have been constructed in the district, but in these, as in the beehive oven, the process is one of partial combustion, not distillation, and no effort is made to recover the by-products or otherwise utilize the gases. The number of coking establishments increased from 117 in 1909 to 118 in 1910. Of the 118 establishments 7, with a total of 380 ovens, were idle throughout the year. The number of ovens in blast in whole or for a part of the year was 24,101, and the average production for each active oven was 475 tons.

The average price for Connellsville coke in 1910 was $2.02, as compared with $1.99 in 1909 and with $2.10 as the average for all Pennsylvania coke in 1910. The apparently low price for Connellsville coke as compared with the average for the State is to some extent due to the fact that the total output from the State includes 2,052,973 tons produced in retort ovens which are located at points distant from the mines, and the value of the coke includes the transportation charges on the coal, whereas in the case of Connellsville coke the ovens are located adjacent to the mines and the transportation charges are borne by the coke.

In the following table are presented the statistics of the manufacture of coke in the Connellsville district in 1880, 1890, 1900, and from 1906 to 1910:

Statistics of the manufacture of coke in the Connellsville region, Pennsylvania, 1880–1910.

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
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	24,422	370	17,581,899	11,769,758	23,379,149	1.99	66.9
1910	118	[a]24,481	206	17,205,615	11,459,601	23,121,556	2.02	66.6

[a] Includes 110 Semet-Solvay by-product ovens.

The following table, compiled by the Connellsville Courier, of Connellsville, Pa., shows the shipments of coke, by months, from the Connellsville and the Lower Connellsville districts. The figures are given in cars and tons with the average number of cars shipped each working day of the month, and include shipments from the Lower Connellsville district as well as from the Connellsville district proper. This authority gives the shipments in 1910 at 18,689,722 short tons, whereas the production for the Connellsville and the Lower Connellsville districts as reported to the Survey amounted to 19,679,093 tons. It is to be noted that the shipments showed a declining tendency during the year. In January the shipments were 64,722 cars, an average of 2,489 cars per day, and a total of 1,952,406 tons of coke. In July the shipments had decreased to 46,194 cars, an average of 1,848 cars per day, and a total of 1,446,294 short tons. In December the number of cars shipped was 37,054 cars, an average of 1,372 cars per day, and the total quantity shipped was 1,196,436 tons. These figures taken in connection with the declining tendency in prices, as shown in a following table, tell the story of Connellsville coke production in 1910.

Shipments of coke from the Connellsville region, including the Lower Connellsville district, in 1909 and 1910, by months.

Month.	1909			1910		
	Cars.	Daily average.	Short tons.	Cars.	Daily average.	Short tons.
January	40,782	1,568	1,205,650	64,722	2,489	1,952,406
February	38,419	1,600	1,143,487	58,357	2,432	1,787,164
March	39,934	1,479	1,185,814	62,329	2,308	1,922,575
April	38,574	1,483	1,144,751	56,601	2,177	1,754,654
May	41,294	1,588	1,235,044	49,426	1,901	1,527,515
June	48,067	1,849	1,429,289	49,127	1,889	1,544,964
July	54,635	2,023	1,605,937	46,194	1,848	1,446,294
August	55,724	2,143	1,641,287	46,260	1,713	1,464,060
September	58,247	2,240	1,704,919	43,857	1,691	1,390,140
October	61,440	2,363	1,821,444	45,860	1,764	1,450,717
November	61,813	2,377	1,835,745	38,919	1,497	1,252,797
December	62,050	2,298	1,832,465	37,054	1,372	1,196,436
Total	600,979	1,920	17,785,832	598,706	1,640	18,689,722

The monthly shipments from this region in the years 1906 to 1910, as reported by the Courier, are given in the following table:

Monthly shipments of coke from the Connellsville and Lower Connellsville regions, 1906–1910, in short tons.

Month.	1906	1907	1908	1909	1910
January	1,665,747	1,698,475	742,096	1,205,650	1,952,406
February	1,435,452	1,625,783	810,436	1,143,487	1,787,164
March	1,683,212	1,701,342	841,059	1,185,814	1,922,575
April	1,604,906	1,708,590	772,915	1,144,751	1,754,654
May	1,739,743	1,787,611	759,813	1,235,044	1,527,515
June	1,654,209	1,677,488	772,367	1,429,289	1,544,964
July	1,662,545	1,741,612	856,843	1,605,937	1,446,294
August	1,685,086	1,787,190	952,492	1,641,287	1,464,060
September	1,610,509	1,650,207	975,606	1,704,919	1,390,140
October	1,850,450	1,805,307	1,030,552	1,821,444	1,450,717
November	1,752,234	1,167,796	995,807	1,835,745	1,252,797
December	1,655,283	677,657	1,190,036	1,832,465	1,196,436
Total	19,999,326	19,029,058	10,700,022	17,785,832	18,689,722

The total shipments, in cars, for the last 23 years were as follows:

Total and daily average shipments, in cars, 1888–1910.

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	1910	1,640	598,706
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 1906 to 1910. 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 year 1910 opened with a continuation of the scarcity of labor supply in the Connellsville region, and with operators embarrassed by these conditions in making deliveries. This helped to maintain prices, but with the improvement in the labor supply, and at the same time the falling off in the iron trade, production soon overtook and exceeded the demand and prices slumped accordingly. The highest prices were those quoted in January, i. e., $2.50 to $2.75 for furnace and $2.85 to $3.25 for foundry. The decline in prices was more noticeable for furnace coke than for foundry. By December furnace coke was sold as low as $1.40, with $1.80 as the high quotation, while foundry coke was quoted at from $1.90 to $2.50. The low price for furnace coke in the latter part of 1910 was the lowest reached during the last six years.

Prices of Connellsville furnace and foundry coke, 1906–1910, by months.

Month.	Furnace.				
	1906	1907	1908	1909	1910
January	$2.15 to $2.75	$3.50 to $3.75	$1.90 to $2.25	$1.50 to $2.00	$2.50 to $2.75
February	2.10 to 2.50	3.50 to 3.65	1.70 to 2.25	1.50 to 1.65	1.75 to 2.60
March	2.20 to 2.50	2.90 to 3.25	1.80 to 1.85	1.55 to 2.00	2.10 to 2.60
April	2.30 to 2.75	2.65 to 2.85	1.50 to 1.60	1.60 to 1.85	1.75 to 2.15
May	2.30 to 2.75	2.00 to 2.85	1.50 to 1.60	1.50 to 1.90	1.65 to 2.00
June	2.30 to 2.50	1.75 to 2.65	1.50 to 1.60	1.50 to 1.75	1.65 to 1.85
July	2.40 to 2.75	2.40 to 2.60	1.50 to 1.60	1.60 to 1.80	1.60 to 1.85
August	2.75 to 2.85	2.40 to 2.85	1.50 to 1.55	1.65 to 2.00	1.60 to 1.85
September	2.85 to 2.90	2.75 to 2.90	1.50 to 1.55	2.00 to 3.00	1.60 to 1.80
October	2.75 to 3.25	2.75 to 3.00	1.50 to 1.65	2.75 to 3.00	1.55 to 1.75
November	3.00 to 3.60	2.00 to 2.75	1.65 to 1.85	2.75 to 2.90	1.45 to 1.75
December	3.00 to 3.60	2.00 to 2.50	1.75 to 1.90	2.60 to 2.90	1.40 to 1.80
Month.	**Foundry.**				
	1906	1907	1908	1909	1910
January	$2.75 to $3.50	$4.00 to $4.50	$2.00 to $2.65	$2.00 to $2.50	$2.85 to $3.25
February	2.50 to 3.00	3.75 to 4.50	2.40 to 2.75	1.85 to 2.25	2.50 to 3.00
March	2.75 to 3.25	3.50 to 4.00	2.10 to 2.40	1.85 to 2.25	2.60 to 3.15
April	2.90 to 3.10	3.25 to 3.75	1.85 to 2.25	1.75 to 2.40	2.50 to 3.00
May	2.65 to 3.10	2.75 to 3.25	2.00 to 2.25	1.80 to 2.35	2.15 to 2.75
June	2.65 to 2.75	3.00 to 3.25	2.00 to 2.25	1.80 to 2.50	2.15 to 2.50
July	2.75 to 3.00	3.00 to 3.25	2.00 to 2.25	1.80 to 2.50	2.15 to 2.50
August	3.00 to 3.25	3.00 to 3.75	1.90 to 2.25	1.70 to 2.50	2.15 to 2.50
September	3.25 to 3.50	3.15 to 3.50	1.90 to 2.00	2.25 to 3.25	2.10 to 2.50
October	3.25 to 4.00	3.25 to 3.40	2.00 to 2.25	2.75 to 3.50	2.15 to 2.50
November	3.75 to 4.50	2.50 to 3.00	2.15 to 2.25	3.00 to 3.50	2.00 to 2.50
December	3.75 to 4.50	2.50 to 2.75	2.15 to 2.25	3.25 to 3.50	1.90 to 2.50

Lower Connellsville district.—This district, which is now the second coke-making district in the United States, was opened in 1900, and at the close of 1910 was only a little more than 10 years old. The production of the Lower Connellsville district in 1900 was 385,909 short tons; in 1910 it was 8,219,492 short tons. In 1909 the Lower Connellsville district produced 6,761,335 short tons, so that the increase in 1910 was 1,458,157 short tons, or 21.6 per cent. This was a little more than the total increase in the production of the State, and it is to be noted that in the Connellsville district the production decreased about 300,000 tons. In 1909 the production of the Lower Connellsville district was a little more than 50 per cent of that of the Connellsville district proper, and in 1910 it was about 75 per cent. The production in the Lower Connellsville district exceeded by nearly 50 per cent the entire production of West Virginia. The value of the coke produced in the Lower Connellsville region increased from $12,490,518 in 1909 to $16,048,675, a gain of $3,558,157, or 28.5 per cent, as compared with the increase of 1,458,157 tons, or 21.6 per cent, in quantity. The number of establishments in the district increased from 70 in 1909 to 73 in 1910, and the total number of ovens from 14,215 to 14,805, all but 30 of which were operated during 1910. The completed ovens included 1,237 rectangular or longitudinal ovens previously described, and which have apparently met with decided favor in this district. At the close of 1910 there were 668 ovens in the course of construction, of which 400 were of the rectangular or longitudinal type. There are no by-product recovery ovens in the district. The average production per oven in 1910 was 556 tons, as compared with 480 tons in 1909.

The record of the district in 1900, and from 1905 to 1910, has been as follows:

Statistics of the manufacture of coke in the Lower Connellsville district, Pennsylvania, 1900, and 1905–1910.

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	14,215	1,036	9,781,803	6,761,335	12,490,518	1.85	69.1
1910	73	[a]14,805	[b]668	12,130,425	8,219,492	16,048,675	1.95	67.8

[a] Includes 1,237 rectangular ovens. [b] Includes 400 rectangular ovens.

TENNESSEE.

The eastern part of Tennessee is crossed, in a northeast-southwest direction, by the coal measures of the Appalachian province. Coal is mined in 17 counties and coke is made in 8. The counties in which coke is made are Campbell, Grundy, Hamilton, Marion, Morgan, Rhea, Roane, and Sequatchie. The larger part of the workable coal in the State occurs in three basins, the Wartburg, the Walden, and the Sewanee. (See report on production of coal, 1910.) Each of these basins contains a number of workable coal beds, as many as seven having been noted in the Walden Basin. Nearly all of the Tennessee coals possess coking qualities, but not all to the same degree, as is attested by the number of idle ovens during the last three years. In 1910 out of 16 establishments, 7 were idle, and out of a total of 2,792 ovens, 1,192, or nearly 43 per cent, were idle. In 1909, 1,178 ovens, and in 1908, 1,430 ovens, were idle. The production of coke in Tennessee in 1910 amounted to 322,756 short tons, valued at $959,104, against 261,808 tons, valued at $667,723, in 1909. The increase in 1910 was 60,948 short tons, or 23.3 per cent in quantity, and $291,381, or 43.6 per cent, in value. The average price per ton in 1910 was the highest obtained for Tennessee coke since 1903. All of the ovens in the State are of the ordinary beehive type.

The statistics of the manufacture of coke in Tennessee in the years 1880, 1890, 1900, and from 1906 to 1910 are shown in the following table:

Statistics of the manufacture of coke in Tennessee, 1880–1910.

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
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	1[illegible]	2,792	0	493,283	261,808	667,723	2.55	53.1
1910	16	2,792	0	597,658	322,756	959,104	2.97	54.0

The quantity of coal used in the manufacture of coke in Tennessee during 1910 was 597,658 short tons, of which 556,008 tons, or 93 per cent, were washed before coking. Of the washed coal 346,769 tons were mine-run and 209,239 tons were slack. The quantities represent the weight of the coal after washing. The quantity of unwashed run-of-mine coal used for coke making in 1910 was 41,650 short tons.

The character of the coal used in the manufacture of coke in Tennessee in 1890, 1900, and since 1906, is shown in the following table:

Character of coal used in the manufacture of coke in Tennessee, 1890, 1900, and 1906–1910, 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
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
1910	41,650	346,769	0	209,239	597,658

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 of 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 & Western Railway, and for 10 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 & 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 & 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, but decreased to 86,000 tons in 1910, the decrease being probably due to the fact that the mines and ovens at Keokee changed hands in the spring of 1910, with partial interruption to mining and coking operations. Production in other districts increased, and the total output for the State showed a gain from 1,347,478 short tons, valued at $2,415,769 in 1909, to 1,493,655 tons, valued at $2,731,348 in 1910. The increase in quantity was 146,177 tons, or 10.9 per cent, while the value increased $315,579, or 13.1 per cent. The average price per ton advanced from $1.79 in 1909 to $1.83 in 1910.

One establishment of 20 ovens was abandoned in 1910, reducing the number of establishments from 19 to 18 and the number of ovens from 5,469 to 5,389. There were 100 beehive ovens in course of construction at the close of 1910. Of the 5,389 ovens, 354 were idle during all of 1910. The idle ovens included the 56 Newton-Chambers ovens at Pocahontas which have not been in practical operation except for a portion of 1899 and 1900, since they were established in 1898. All of the other ovens in the State are of the beehive type. The coke manufactured in Wise County, on the Clinch Valley branch of the Norfolk & 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 ovens, 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 1906 to 1910, inclusive, are shown in the following table:

Statistics of the manufacture of coke in Virginia, 1883–1910.

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
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	5,469	100	2,060,518	1,347,478	2,415,769	1.79	65.1
1910	18	[a] 5,389	100	2,310,742	1,493,655	2,731,348	1.83	64.6

[a] Includes 56 Newton-Chambers ovens.

About 70 per cent of the coal used for coke making in Virginia is unwashed run-of-mine. In 1910 out of 2,310,742 short tons of coal made into coke, 1,554,784 tons were of this grade. The quantity of slack used was 755,958 short tons, all of which was unwashed.

The following table shows the character of the coal used in coke making in Virginia in 1890, 1900, and from 1906 to 1910:

Character of coal used in the manufacture of coke in Virginia, 1890–1910, 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
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
1910	1,554,784	0	755,958	0	2,310,742

WASHINGTON.

Washington is the only State west of the Rocky Mountains that contains coal possessing coking qualities, and the coking industry of Washington is restricted to a limited area in Pierce County. Tests made at the experimental plant of the United States Geological Survey at Denver in 1908 showed that a fair quality of coke could be made from the coal mined in the northern part of the Roslyn field in Kittitas County (the only workable coal in Washington east of the Cascades), but so far no attempt has been made to coke this coal on a commercial scale. There are 6 establishments in the State, and of these, 3, all in the Wilkeson-Carbonado field in Pierce County, made coke in 1909 and 1910. The 3 active establishments had a total of 185 ovens. The 3 idle plants had a total of 100 ovens. All of the ovens in the State are of the beehive type.

The total production of coke in Washington in 1910 amounted to 59,337 short tons, valued at $347,540, against 42,981 short tons, valued at $240,604 in 1909. Both in quantity and value the production in 1910 exceeded all previous records. Compared with 1909, it showed a gain of 16,356 short tons, or 38.1 per cent, in quantity, and of $106,936, or 44.4 per cent, in value. The percentage of increase, both in quantity and value, was the largest shown by any of the coke-producing States in 1910. The larger relative gain in value, however, was more apparent than real, for of the total increase of $106,936 in 1910 over 1909, $96,161 was in the value of the coal charged into the ovens, and the net increase in the value of the coke was accordingly only $10,775, whereas the quantity of coke produced increased 16,356 short tons. The number of establishments and the number of ovens were the same in 1910 as in 1909, and there was no new construction in progress at the close of 1910. The report of a contemplated plant of by-product recovery ovens at South Seattle mentioned in the report for 1909 was without foundation.

All of the coal used in coking in Washington is washed before being charged into the ovens. Of the total quantity coked, 3,361 short tons, or about 3 per cent, were run of mine, and 90,862 tons were slack.

The coke industry of Washington began in 1884, when 400 tons of coke were made in pits. The first ovens were built in 1885. The statistics of production in 1884, 1890, 1900, and from 1906 to 1910 are as follows:

Statistics of the manufacture of coke in Washington, 1884–1910.

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
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
1910	6	285	0	94,223	59,337	347,540	5.86	63.0

WEST VIRGINIA.

In the quantity of coke produced West Virginia has for several years held second place among the States, but is outranked by Alabama in the value of the product. The reason for this lies in the fact that the output of Alabama has in the iron-manufacturing center of Birmingham and vicinity a local consumptive market, whereas practically all of the West Virginia coke is shipped to furnaces outside of the State. In reaching for these markets the coke of West Virginia not only has to meet in competition the product from other States, but one district in the State becomes a rival with other West Virginia districts, and the result is exhibited in the statistics of production and value. Alabama ranks third as a coke-producing State, with a production in 1910 smaller than that of West Virginia by more than 550,000 tons, but the value of Alabama's product exceeded that of West Virginia by over $1,800,000. The quantity of coke produced in West Virginia in 1910 was 3,803,850 short tons, valued at $7,354,039. Alabama's production was 3,249,027 short tons, and the value was $9,165,821. The quality of West Virginia coke exceeds that of Alabama's, but the average price of Alabama coke in 1910 was $2.82 per ton; the average price for West Virginia coke was $1.93.

Next to Pennsylvania, West Virginia possesses more wealth in supplies of coking and other high-grade coals than any other State in the Union, but as long as both the coal and the coke are continued to be shipped out of the State, West Virginia will not attain the position she should occupy as a manufacturing State, nor will the miners of coal and makers of coke receive a just return for these products. At the present time, ranking second as a producer of coal and coke, West Virginia stands thirty-fourth in the value of her manufactured products. The principal beneficiaries in the State of the coal-mining and coke-making industries are the transportation companies.

In most of the coke-producing States the output in 1910 exceeded that of 1909. West Virginia was one of the exceptions, with a decrease of 140,098 short tons, or 3.55 per cent, from 3,943,948 tons in 1909, to 3,803,850 tons in 1910. The value decreased $171,883, or 2.28 per cent, from $7,525,922 to $7,354,039. The number of establishments was reduced from 138 in 1909 to 135 in 1910, and the number of coke ovens from 20,283 to 19,912, and the number of idle ovens increased from 2,274 to 2,590. The abandoned plants and most of the idle ovens were in the Upper Monongahela district. With the exception of 120 Semet-Solvay ovens at Benwood, all of the ovens in the State are of the beehive type, and no attempt is made to otilize the heat generated in the process.

In the following table will be found the statistics of the manufacture fn coke in West Virginia in 1880, 1890, 1900, and for the last five years:

Statistics of the manufacture of coke in West Virginia, 1880–1910.

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
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	20,283	126	6,361,759	3,943,948	7,525,922	1.91	62.0
1910	135	[a]19,912	230	6,226,234	3,803,850	7,354,039	1.93	61.1

[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 6,226,234 tons of coal charged in 1910 into the ovens, 5,551,480 tons were unwashed, and 674,754 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 1906 to 1910, is shown in the following table:

Character of coal used in the manufacture of coke in West Virginia, 1890–1910, 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
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
1910	2,088,553	234,484	3,462,927	440,270	6,226,234

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 & 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 Co. at Ansted are included in the New River district, although the Ansted coal belongs in reality to the coal series of the Kanawha district 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 the Flat Top-Tug River district averages somewhat more than 50 per cent of the total coke production of the State.

The statistics of the production of coke in West Virginia by districts in 1909 and 1910 are shown in the following tables:

Production of coke in West Virginia in 1909 and 1910.

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.					
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	1.91	62.0

1910.

District.	Establishments.	Ovens built.	Ovens building.	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).
Flat Top[a]	53	11,866	0	3,641,948	2,203,793	4,138,870	$1.88	60.5
Kanawha	11	1,697	0	625,164	378,921	790,810	2.09	60.6
New River	23	1,781	0	532,276	328,267	705,388	2.15	61.7
Upper Monongahela	36	[b]3,068	150	893,882	551,854	1,062,438	1.93	61.7
Upper Potomac and Tygarts Valley	12	1,500	80	532,964	341,015	656,533	1.93	64.0
Total	135	19,912	230	6,226,234	3,803,850	7,354,039	1.93	61.1

[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 there are less than three establishments in operation. Eleven States are included for 1910, namely, Indiana, Kansas, Maryland, Massachusetts, Michigan, Minnesota, Montana, New Jersey, New York, Oklahoma, and Wisconsin. Two of these States, Kansas and Oklahoma, produced no coke in 1909. In the 11 States included in this statement there were in 1910, 28 establishments, of which 12, with a total of 522 ovens, were idle. The 16 active establishments included a total of 2,404 ovens, of which 1,728 ovens were of the by-product recovery type. One establishment of 100 ovens in Montana and one of 80 ovens in Oklahoma were abandoned during 1910. The most important construction work in progress at the close of 1910 was the plant of 560 Koppers ovens building at Gary, Ind., by the United States Steel Corporation. Work on this plant was begun in 1909, but was not completed by January 1, 1911.

The combined production of the 11 States named amounted in 1910 to 2,822,231 short tons, valued at $10,432,395. The 9 States included in the statement for 1909 produced 2,509,306 short tons, valued at $9,129,282. The increase in 1910 over 1909 was 312,925 short tons, or 12.5 per cent, in quantity and $1,303,113, or 14.3 per cent, in value.

Six of the 11 States included in this statement—Maryland, Michigan, Minnesota, New Jersey, New York, and Wisconsin—secure the coal for coke making from the mines of other States, and Massachusetts obtains its supply of coal from Nova Scotia and West Virginia. All of the ovens in these States, with the exception of one plant of 228 beehive ovens in Wisconsin, are by-product recovery ovens. The relatively high percentage yield of coal in coke, as shown in the following table, is due to the large proportion of by-product coke, and the high value for the product is due to the distance of most of the ovens from the mines and the addition of the freight charges to the cost of the coal.

The statistics of production in the States having less than three establishments each since 1900 are shown in the following table:

Statistics of coke production from 1900 to 1910 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	2,553	563	3,427,732	2,509,306	9,129,282	3.64	73.3
1910	28	[a] 2,926	[b] 563	3,840,467	2,822,231	10,432,395	3.70	73.5

[a] Includes 378 Semet-Solvay, 1,068 United-Otto, and 282 Rothberg ovens.
[b] Includes 560 Koppers ovens.

NATURAL GAS.

By B. Hill.

INTRODUCTION.

By David T. Day.

The development of a great natural-gas field in California and the increase in the installation of great pumping stations, especially in the Mid-Continent field, were the features of especial interest in the natural-gas industry in 1910.

Production again more than held its own, so that the quantity produced increased from 480,706,174,000 cubic feet of natural gas consumed in 1909, to 509,155,309,000 cubic feet in 1910. The price at which the gas was sold by the original producer continued to increase slowly because no new sources were found of sufficient size to oversupply the market at any point in the established trade. The great outburst in California provided a new field not in competition with any other, which hence had no influence on prices. The total value for the United States amounted to $70,756,158 in 1910, an increase from $63,206,941 in 1909 of 11.94 per cent.

The following tables show the value of the gas consumed, by States. It should be borne in mind that these statistics take account only of the gas which was actually used. Thus the production includes, besides gas burned for light and fuel, the quantity consumed in extracting gasoline and in making carbon black (lampblack), but does not include any estimate of the quantity wasted by using the gas pressure in place of steam in steam engines, a practice prohibited by law in most States. An estimate is included of the gas used by gas engines in pumping and drilling oil wells and in operating pumps for compressing natural gas.

Without doubt the much-discussed waste of natural gas is decreasing rapidly. The problem of natural gas conservation may be considered as satisfactory in Pennsylvania and throughout the Appalachian and the Lima-Indiana fields, and in Kansas. The greatest waste is in Oklahoma and in the Caddo field of Louisiana, owing in Oklahoma to faulty execution of the laws, and in Louisiana to lack of a market. It is noteworthy that one of the two wild wells that have been the sensational examples of waste was successfully closed shortly after the end of the year.

PRODUCTION AND CONSUMPTION.

The following table gives, by States, the total value of the natural gas produced in the entire country from 1883 to 1910, inclusive:

Approximate value of natural gas produced in the United States, 1883–1910, by States.

State.	1883	1884	1885	1886	1887	1888	1889
Pennsylvania	$200,000	$1,100,000	$4,500,000	$9,000,000	$13,749,500	$19,282,375	$11,593,989
New York	....	....	196,000	210,000	333,000	332,500	530,026
Ohio	....	....	100,000	400,000	1,000,000	1,500,000	5,215,669
West Virginia	....	....	40,000	60,000	120,000	120,000	12,000
Illinois	....	....	1,200	4,000	....	....	10,615
Indiana	....	....	....	300,000	600,000	1,320,000	2,075,702
Kansas	....	....	....	6,000	....	....	15,873
Missouri	....	....	....	....	....	....	35,687
California	....	....	....	....	....	....	12,680
Kentucky and Tennessee	....	....	....	....	....	....	2,580
Texas and Alabama	....	....	....	....	....	....	1,728
Arkansas and Wyoming	....	....	....	....	....	....	375
Utah	....	....	....	....	....	....	....
Colorado	....	....	....	....	....	....	....
South Dakota	....	....	....	....	....	....	....
Indian Territory and Oklahoma	....	....	....	....	....	....	....
Louisiana	....	....	....	....	....	....	....
Other	275,000	360,000	20,000	32,000	15,000	75,000	1,600,175
Total	475,000	1,460,000	4,857,200	10,012,000	15,817,500	22,629,875	21,107,099

State.	1890	1891	1892	1893	1894	1895	1896
Pennsylvania	$9,551,025	$7,834,016	$7,376,281	$6,488,000	$6,279,000	$5,852,000	$5,528,610
New York	552,000	280,000	216,000	210,000	249,000	241,530	256,000
Ohio	4,684,300	3,076,325	2,136,000	1,510,000	1,276,100	1,255,700	1,172,400
West Virginia	5,400	35,000	70,500	123,000	395,000	100,000	640,000
Illinois	6,000	6,000	12,988	14,000	15,000	7,500	6,375
Indiana	2,302,500	3,942,500	4,716,000	5,718,000	5,437,000	5,203,200	5,043,635
Kansas	12,000	5,500	40,795	50,000	86,600	112,400	124,750
Missouri	10,500	1,500	3,775	2,100	4,500	3,500	1,500
California	33,000	30,000	55,000	62,000	60,350	55,000	55,682
Kentucky and Tennessee	30,000	38,993	43,175	68,500	89,200	98,700	99,000
Texas and Alabama	....	....	100	50	50	20	....
Arkansas and Wyoming	....	250	100	100	100	100	60
Utah	....	....	....	500	500	20,000	20,000
Colorado	....	....	....	....	12,000	7,000	4,500
South Dakota	....	....	....	....	....	....	....
Indian Territory and Oklahoma	....	....	....	....	....	....	....
Louisiana	....	....	....	....	....	....	....
Other	1,606,000	250,000	200,000	100,000	50,000	50,000	50,000
Total	18,792,725	15,500,084	14,870,714	14,346,250	13,954,400	13,006,650	13,002,512

Approximate value of natural gas produced in the United States, 1883–1910, by States—Continued.

State.	1897	1898	1899	1900	1901	1902	1903
Pennsylvania	$6,242,543	$6,806,742	$8,337,210	$10,215,412	$12,688,161	$14,352,183	$16,182,834
New York	200,076	229,078	294,593	335,367	293,232	346,471	493,686
Ohio	1,171,777	1,488,308	1,866,271	2,178,234	2,147,215	2,355,458	4,479,040
West Virginia	912,528	1,334,023	2,335,864	2,959,032	3,954,472	5,390,181	6,882,359
Illinois	5,000	2,498	2,067	1,700	1,825	1,844	3,310
Indiana	5,009,208	5,060,969	6,680,370	7,254,539	6,954,566	7,081,344	6,098,364
Kansas	105,700	174,640	332,592	356,900	659,173	824,431	1,123,849
Missouri	500	145	290	547	1,328	2,154	7,070
California	50,000	65,337	86,891	79,083	67,602	120,648	104,521
Kentucky and Tennessee	90,000	103,133	125,745	286,243	270,871	365,656	390,601
Texas and Alabama	....	765	8,000	20,000	18,577	14,953	13,851
Arkansas and Wyoming	40	....	....	....	....	....	2,460
Utah	15,050	7,875	....	....	....	....	....
Colorado	4,000	3,300	1,480	1,800	1,800	1,900	14,140
South Dakota	....	....	3,500	9,817	7,255	10,280	10,775
Indian Territory and Oklahoma	....	....	....	....	....	360	1,000
Louisiana	....	....	....	....	....	....	....
Other	20,000	20,000	....	....	....	....	....
Total	13,826,422	15,296,813	20,074,873	23,698,674	27,066,077	30,867,863	35,807,860

State.	1904	1905	1906	1907	1908	1909	1910
Pennsylvania	$18,139,914	$19,197,336	$18,558,245	$18,844,156	$19,104,944	$20,475,207	$21,057,211
New York	522,575	623,251	672,795	766,157	959,280	1,222,666	1,678,720
Ohio	5,315,564	5,721,462	7,145,809	8,718,562	8,244,835	9,966,938	8,626,954
West Virginia	8,114,249	10,075,804	13,735,343	16,670,962	14,837,130	17,538,565	23,816,553
Illinois	4,745	7,223	87,211	143,577	446,077	644,401	613,642
Indiana	4,342,409	3,094,134	1,750,715	1,572,605	1,312,507	1,616,903	1,473,403
Kansas	1,517,643	2,261,836	4,010,986	6,198,583	7,691,587	8,293,846	7,755,367
Missouri	6,285	7,390	7,210	17,010	22,592	10,025	12,611
California	114,195	133,696	134,560	168,397	307,652	446,933	476,697
Alabama							
Texas	14,082	14,409	150,695	178,276	236,837	453,253	956,683
Louisiana	....	1,500					
Kentucky	322,104	237,290	287,501	380,176	424,271	485,192	456,293
Tennessee	300	300	300	300	350	350	300
Arkansas and Wyoming	6,515	21,135	34,500	126,582	164,930	226,925	301,151
Colorado	14,300	20,752	22,800				
South Dakota	12,215	15,200	15,400	19,500	24,400	16,164	31,999
Oklahoma	49,665	130,137	259,862	417,221	860,159	1,806,193	3,490,704
North Dakota	....	....	....	235	2,480	3,025	7,010
Oregon	....	....	....	100	250	50	....
Iowa	....	....	....	....	93	50	40
Michigan	....	....	....	....	....	255	820
Total	38,496,760	41,562,855	46,873,932	54,222,399	54,640,374	63,206,941	70,756,158

The following table shows the production and consumption of natural gas in 1909 and 1910, by States:

Quantity and value of natural gas produced and consumed in the United States in 1909 and 1910, by States.

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

1910.

State.	Produced quantity, M cubic feet.	Cents per M cu. ft.	Value.	Consumed quantity, M cubic feet.	Cents per M cu. ft.	Value.
West Virginia	190,705,869	12.49	$23,816,553	77,067,756	7.16	$5,617,910
Pennsylvania	126,866,729	16.60	21,057,211	168,875,559	14.17	23,934,691
Ohio	48,232,406	17.89	8,626,954	108,074,660	19.63	21,210,965
Kansas	59,380,157	13.06	7,755,367	[a] 81,929,740	11.19	9,163,863
Oklahoma	50,429,646	6.92	3,490,704	[b] 27,880,063	7.47	2,082,208
New York	6,009,598	27.93	1,678,720	14,194,804	27.92	3,963,872
Indiana	5,760,252	25.58	1,473,403	5,760,252	25.58	1,473,403
Louisiana, Texas, Alabama	8,110,502	11.79	956,683	8,110,502	11.80	956,683
Illinois	6,723,286	9.13	613,642	6,723,286	9.13	613,642
California	2,764,507	17.24	476,697	2,764,507	17.24	476,697
Kentucky	1,356,771	33.63	456,293	4,958,594	18.32	908,293
Arkansas, Colorado, Wyoming	2,704,948	11.13	301,151	2,704,948	11.13	301,151
South Dakota	43,374	73.77	31,999	43,374	73.77	31,999
Missouri	47,144	26.75	12,611	47,144	26.75	12,611
North Dakota	17,620	39.78	7,010	17,620	39.78	7,010
Michigan	1,220	67.21	820	1,220	67.21	820
Tennessee	1,200	25.00	300	1,200	25.00	300
Iowa	80	50.00	40	80	50.00	40
Total	509,155,309	13.90	70,756,158	509,155,309	13.90	70,756,158

[a] Includes gas piped from Kansas and consumed in Missouri; also gas piped from Oklahoma into Kansas.
[b] Includes some gas which was piped to Missouri.

The following tables show the distribution of natural gas consumed in 1909 and 1910, by States:

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	50.00	255
Iowa	....	....	....	100	50.00	50
Oregon	....	....	....	100	50.00	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 natural gas consumed in the United States in 1910, 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	819	1,584	2,403	321,430	5,591	43,404,565	25.3	$10,972,250
Ohio	1,630	638	2,268	475,505	3,804	60,539,597	25.0	15,145,537
Kansas [a]	204	38	242	185,972	1,228	23,792,122	21.9	5,202,914
West Virginia [b]	241	189	430	86,778	2,823	13,637,059	17.4	2,377,276
New York	273	375	648	106,538	1,058	12,247,528	29.7	3,646,180
Oklahoma [c]	168	343	511	38,978	2,059	5,397,284	16.9	912,958
Indiana [d]	1,027	117	1,144	36,054	282	4,315,403	30.1	1,299,247
Kentucky	47	21	68	27,961	112	2,574,352	27.9	718,657
Illinois [e]	207	227	434	10,109	479	1,266,057	21.9	278,377
Louisiana	21	....	21	8,547	320			
Texas	19	20	39	14,719	133	1,616,332	31.8	514,782
Alabama	7	....	7	95	6			
California	30	124	154	8,292	217	245,738	79.2	194,631
Arkansas	9	....	9	4,422	121			
Colorado	5	11	16	1,051	13	722,895	24.8	179,324
Wyoming	5	2	7	353	4			
South Dakota	37	....	37	371	8	23,074	77.6	17,899
Missouri	33	1	34	322	5	22,704	28.6	6,501
North Dakota	14	....	14	212	3	16,620	39.8	6,610
Michigan	8	1	9	7	1	420	100.0	420
Tennessee	5	....	5	2	....	1,200	25.0	300
Iowa	5	....	5	4	....	80	50.0	40
Total	4,814	3,691	8,505	1,327,722	18,267	169,823,030	24.4	41,473,903

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	125,470,994	10.3	$12,962,441	168,875,559	14.17	$23,934,691
Ohio	47,535,063	12.8	6,065,428	108,074,660	19.63	21,210,965
Kansas [a]	58,137,618	6.8	3,960,949	81,929,740	11.19	9,163,863
West Virginia [b]	63,430,697	5.1	3,240,634	77,067,756	7.29	5,617,910
New York	1,947,276	16.3	317,692	14,194,804	27.92	3,963,872
Oklahoma [c]	22,482,779	5.2	1,169,250	27,880,063	7.47	2,082,208
Indiana [d]	1,444,849	12.1	174,156	5,760,252	25.58	1,473,403
Kentucky	2,384,242	8.0	189,636	4,958,594	18.32	908,293
Illinois [e]	5,457,229	6.1	335,265	6,723,286	9.13	613,642
Louisiana						
Texas	6,494,170	6.8	441,901	8,110,502	11.80	956,683
Alabama						
California	2,518,769	11.2	282,066	2,764,507	17.24	476,697
Arkansas						
Colorado	1,982,053	6.1	121,827	2,704,948	11.13	301,151
Wyoming						
South Dakota	20,300	69.5	14,100	43,374	73.77	31,999
Missouri	24,440	25.0	6,110	47,144	26.75	12,611
North Dakota	1,000	40.0	400	17,620	39.78	7,010
Michigan	800	50.0	400	1,220	67.21	820
Tennessee	....	....	....	1,200	25.00	300
Iowa	....	....	....	80	50.00	40
Total	339,332,279	8.63	29,282,255	509,155,309	13.90	70,756,158

[a] Includes the consumption of gas piped from Kansas to Missouri.
[b] Includes the consumption of gas piped from West Virginia to Maryland.
[c] Includes the consumption of gas piped from Oklahoma to Missouri.
[d] Includes the consumption of gas piped from Indiana to Chicago, Ill.
[e] Includes the consumption of gas piped from Illinois to Vincennes, Ind.

The following table gives the distribution of gas consumed for industrial purposes in 1909 and 1910, by States:

Distribution of gas consumed for industrial purposes in 1909 and 1910, by States.

1909.

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......	1,680,177	8.9	148,707	1,914,081	5.0	95,772	3,594,258	6.8	244,479
Alabama......									
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.......	(a)	......	(a)	1,480,753	5.8	85,467	1,480,753	5.8	85,467
Wyoming.....									
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

1910.

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 .	115,465,481	10.1	$11,690,116	10,005,513	12.7	$1,272,325	125,470,994	10.3	$12,962,441
Ohio..........	41,874,927	12.7	5,298,299	5,660,136	13.6	767,129	47,535,063	12.8	6,065,428
Kansas........	53,505,871	6.7	3,588,355	4,631,747	8.0	372,594	58,137,618	6.8	3,960,949
West Virginia..	52,473,928	5.0	2,671,607	10,956,769	5.2	569,027	63,430,697	5.1	3,240,634
New York.....	408,943	17.4	71,063	1,538,333	16.0	246,629	1,947,276	16.3	317,692
Oklahoma.....	12,410,219	4.3	531,983	10,072,560	6.3	637,267	22,482,779	5.2	1,169,250
Indiana........	422,363	15.1	63,667	1,022,486	10.8	110,489	1,444,849	12.1	174,156
Kentucky.....	2,226,062	7.4	165,320	158,180	15.4	24,316	2,384,242	8.0	189,636
Illinois.........	925,946	9.0	83,763	4,531,283	5.6	251,502	5,457,229	6.1	335,265
Louisiana......									
Texas..........	2,083,481	9.1	189,704	4,410,689	5.7	252,197	6,494,170	6.8	441,901
Alabama......									
California......	....	......	....	2,518,769	11.2	282,066	2,518,769	11.2	282,066
Arkansas......									
Colorado.......	(a)	......	(a)	1,982,053	6.1	121,827	1,982,053	6.1	121,827
Wyoming.....									
South Dakota..	....	......	....	20,300	69.5	14,100	20,300	69.5	14,100
Missouri........	....	......	....	24,440	25.0	6,110	24,440	25.0	6,110
North Dakota.	....	......	....	1,000	40.0	400	1,000	40.0	400
Michigan.......	....	......	....	800	50.0	400	800	50.0	400
Tennessee.....	....	......	....	....	......	....	....	......	....
Iowa...........	....	......	....	....	......	....	....	......	....
Total....	281,797,221	8.64	24,353,877	57,535,058	8.57	4,928,378	339,332,279	8.63	29,282,255

[a] Included in other industrial.

Value of natural gas consumed in the United States, 1905–1910, by States.

State.	1905	1906	1907	1908	1909	1910
Pennsylvania	$19,237,218	$21,085,077	$22,917,547	$20,678,161	$21,639,102	$23,934,691
Ohio	10,396,633	12,652,520	15,227,780	15,166,434	18,884,312	21,210,965
Kansas	2,265,945	a 4,030,776	a 6,208,862	a 7,691,587	a 8,356,076	a 9,163,863
Missouri	7,390		17,010	22,592	10,025	12,611
West Virginia	3,586,608	3,720,440	b 3,757,977	b 4,020,282	b 5,183,054	b 5,617,910
New York	2,434,894	2,654,115	3,098,533	3,281,312	3,286,523	3,963,872
Indiana	c 3,056,634	c 1,750,755	c 1,570,605	c 1,312,507	c 1,616,903	c 1,473,403
Kentucky	237,290	287,501	380,176	424,271	695,577	908,293
Oklahoma	126,028	247,282	406,942	860,159	1,743,963	2,082,208
Alabama, Texas	14,409	150,695	178,276	236,837	453,253	956,683
Louisiana	1,500					
California	133,696	134,560	168,397	307,652	446,933	476,697
Illinois	7,223	87,211	143,577	d 446,077	d 644,401	d 613,642
Arkansas, Wyoming	21,135	34,500	126,582	164,930	226,925	301,151
Colorado	20,752	22,800				
South Dakota	15,200	15,400	19,500	24,400	16,164	31,999
Tennessee	300	300	300	350	350	300
North Dakota	....	....	235	2,480	3,025	7,010
Oregon	....	....	100	250	50	....
Iowa	....	....	....	93	50	40
Michigan	....	....	....	....	255	820
Total	41,562,855	46,873,932	54,222,399	54,640,374	63,206,941	70,756,158

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.

It will be seen that there has been little change in the rank of the States as natural-gas producers. This in itself evinces the success in efficiently conserving the gas supply in the older regions.

It is worth while to note that the combined value of the liquid and gaseous fuel product in the United States exceeds that of any other mineral product except coal, and is greater than the combined value of gold, silver, lead, zinc, quicksilver, and of all other metals except iron and copper. The total steam-raising power of the gas and oil products compares to the total for coal in the proportion of 1 to 7.

The following table gives the value of natural gas and of petroleum and their combined value in 1909 and 1910, by States, arranged in the order of the value of the combined production:

Value of the natural gas and petroleum produced in 1909 and 1910, and their combined value, by States.

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	30,756,713	31,203,646
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	318,162	579,543
Wyoming		34,456	
Utah	....		
Michigan	255	7,830	18,110
Missouri	10,025		
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	128,328,487	191,535,428

a Estimated.

1910.

State.	Value of natural gas.	Value of crude petroleum.	Value of natural gas and crude petroleum.
West Virginia	$23,816,553	$15,720,184	$39,536,737
California	476,697	35,749,473	36,226,170
Pennsylvania	21,057,211	11,908,914	32,966,125
Oklahoma	3,490,704	19,922,660	23,413,364
Illinois	613,642	19,669,383	20,283,025
Ohio	8,626,954	10,651,568	19,278,522
Texas		6,605,755	
Louisiana	956,683	3,574,069	11,136,507
Alabama			
Kansas	7,755,367	444,763	8,200,130
New York	1,678,720	1,414,668	3,093,388
Indiana	1,473,403	1,568,475	3,041,878
Kentucky	456,293	324,684	780,977
Arkansas			
Colorado	301,151	243,402	638,089
Wyoming		93,536	
Utah	....		
South Dakota	31,999	....	31,999
Missouri	12,611	4,794	18,225
Michigan	820		
North Dakota	7,010	....	7,010
Tennessee	300	....	300
Iowa	40	....	40
Total	70,756,158	127,896,328	198,652,486

WELL RECORD.

The following table gives the record of natural-gas wells in 1910, by States:

Record of natural-gas wells in 1910, by States.

State.	Productive Dec. 31, 1909.	Drilled in 1910.			Abandoned in 1910.	Productive Dec. 31, 1910.
		Gas.	Dry.	Total.		
Alabama	16	5	4	9	3	18
Arkansas	67	37	10	47	1	103
California	64	3	2	5	12	55
Colorado	4	1	1	2	....	5
Illinois	423	64	31	95	52	435
Indiana	2,938	69	33	102	302	2,705
Iowa	6	....	......	....	....	6
Kansas	2,138	392	195	587	423	2,107
Kentucky	212	23	12	35	18	217
Louisiana	70	23	4	27	2	91
Michigan	7	....	......	....	....	[a] 7
Missouri	47	4	4	8	2	49
New York	1,340	97	20	117	26	1,411
North Dakota	19	3	......	3	3	[b] 19
Ohio	4,260	466	202	668	351	4,375
Oklahoma	454	93	58	151	45	502
Pennsylvania	9,499	857	161	1,018	327	10,029
South Dakota	39	1	......	1	....	[a] 40
Tennessee	5	....	......	....	....	5
Texas	38	22	5	27	1	59
West Virginia	3,074	883	69	952	182	3,775
Wyoming	14	6	6	12	....	20
Total	24,734	3,049	817	3,866	1,750	26,033

[a] Artesian wells from which gas is used.
[b] Includes 6 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 1909 and 1910, and whether the acreage was owned in fee or leased:

Acreage controlled by natural-gas companies in 1909 and 1910, by States.

State.	1909				1910			
	In fee.	Leased.	Gas rights.	Total.	In fee.	Leased.	Gas rights.	Total.
Alabama	570	23,000	....	23,570	570	23,000	....	23 570
Arkansas	530	42,404	3,114	46,048	....	22,027	300	22,327
California	625	2,001	800	3,426	269	1,280	....	1,549
Colorado	....	35	....	35	....	35	....	35
Illinois	1,234	63,170	2,151	66,555	5	81,628	25,600	107,233
Indiana	51,318	142,750	24,596	218,664	62,648	124,858	15,151	202,657
Kansas	29,883	506,706	10,217	546,806	25,825	427,464	2,370	455,659
Kentucky	64	120,388	23,333	143,785	1,343	137,077	....	138,420
Louisiana	19,490	293,273	....	312,763	17,962	337,103	27,200	382,265
Missouri	364	2,010	....	2,374	463	2,050	....	2,513
New York	10,285	173,126	7,312	190,723	9,275	505,603	554	515,432
North Dakota	....	20,320	....	20,320	....	21,200	....	21 200
Ohio	15,123	1,059,996	19,850	1,094,969	32,564	845,404	545,383	1,423,351
Oklahoma	4,647	109,130	747,953	861,730	5,967	816,047	98,396	920,410
Pennsylvania	116,315	1,509,462	220,299	1,846,076	84,994	1,464 534	400,205	1,949,733
Tennessee	500	....	....	500	500	....	....	500
Texas	1,845	19,653	131,597	153,095	7,394	395,335	54,685	457,414
West Virginia	17,606	2,564,273	631,080	3,212,959	19,673	3,042,437	286,176	3,348,286
Wyoming	944	1,640	....	2,584	1,794	1,370	....	3,164
Total	271,343	6,653,337	1,822,302	8,746,982	271,246	8,248,452	1,456,020	9,975,718

NATURAL-GAS INDUSTRY BY STATES.

PENNSYLVANIA.

The State of Pennsylvania in 1910, as in previous years, took first place in the consumption of natural gas. The total quantity of gas consumed in 1910 was 168,875,559,000 cubic feet, valued at $23,934,691, as compared with 163,656,145,000 cubic feet, valued at $21,639,102 in 1909. The production of natural gas in Pennsylvania was less in 1910 than in 1909, but the value received for the gas produced was greater. The quantity and value of the gas produced in 1910 was 126,866,729,000 cubic feet, valued at $21,057,211; in 1909 it amounted to 127,697,104,000 cubic feet, valued at $20,475,207.

The report shows that the average price received per thousand cubic feet for gas consumed in Pennsylvania in 1910 was 14.17 cents, as compared with 13.22 cents in 1909, a slight increase.

Although a large supply of gas consumed in Pennsylvania was piped from the West Virginia gas fields, Pennsylvania also piped gas to West Virginia and Ohio and a considerable quantity to New York State, the last-named State receiving 8,185,206,000 cubic feet, valued at $2,285,152 in 1910.

No information has been received concerning the discovery of any new gas fields in Pennsylvania since the report for 1909. A total of 1,018 gas wells was drilled by producers, of which 857 were productive and 161 were dry holes, making the total number of productive gas wells 10,029 at the close of 1910. During the year 1910 the number of gas wells abandoned was 327.

Record of natural-gas industry in Pennsylvania, 1897–1910.

Years.	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] 9,499
1910	[b] 819	21,057,211	321,430	5,591	23,934,691	857	161	[c] 10,029

[a] Number of fires supplied.
[b] Includes 216 producers having shallow wells in Erie County for their own domestic consumption in 1908, 311 producers in 1909, and 345 producers in 1910.
[c] Includes 350 shallow wells in Erie County in 1908, 429 wells in 1909, and 429 wells in 1910.

Depth and gas pressure of wells in Pennsylvania, 1907–1910, by counties.

County.	Depth, in feet.	Pressure, in pounds.			
		1907	1908	1909	1910
Allegheny	900–3,000	7– 400	1–350	10–600	10–600
Armstrong	702–3,000	6– 800	2–600	25–900	3–800
Beaver	700–1,500	4	...	4–600	4– 75
Butler	800–2,600	15– 625	15–550	30–600	6–700
Clarion	600–3,000	3– 700	15–500	8–800	25–900
Elk	910–3,200	49– 960	50–940	50–990	50–990
Crawford Erie	600– 900 300–1,600	10– 200	100	1– 85	0– 85
Fayette and Cambria	900–2,500	100– 550	200–550	100–700	100–650
Forest	700–2,600	75– 250	85–160	15–145	10–850
Greene	1,400–3,600	80–1,200	70–350	50–500	40–400
Indiana	1,100–1,500	...	...	...	...
Jefferson	1,350–3,040	200– 500	325–760	10–635	100–700
McKean	750–2,665	20– 450	15–500	30–600	6–600
Mercer	700–1,500	...	...	40	...
Potter	750–2,200	40– 360	100–460	60–500	50–300
Tioga	730–1,400	350	300	250	300
Venango	400–2,100	70– 150	40–400	20–250	10– 85
Warren	600–2,050	10– 60	14–250	20– 50	10–190
Washington	606–3,304	15– 100	5–400	12–500	5–800
Westmoreland	1,800–3,300	25	10– 30	50–180	10– 25

NEW YORK.

In the year 1910 the total consumption of gas in New York amounted to 14,194,804,000 cubic feet, valued at $3,963,872, an average price of 27.92 cents per thousand cubic feet; the consumption in 1909 was 13,204,982,000 cubic feet, valued at $3,286,523, an average price of 24.89 cents per thousand cubic feet, showing an increase in both quantity and value of product. The total quantity of gas produced in New York in 1910 was 6,009,598,000 cubic feet, valued at $1,678,720, as compared with 4,695,735,000 cubic feet, valued at $1,222,666, in 1909. The difference between the quantity of gas produced and the quantity of gas consumed in the State shows the quantity of gas piped into the State from the gas fields of Pennsylvania, upon whose product the consumers of New York are so largely dependent.

No new developments have been reported in the natural-gas industry of New York since the report for 1909. A few plants for the extraction of gasoline from surplus gas are in operation, but no statistics from them have been obtained.

The number of productive gas wells in New York at the close of 1910 was 1,411, including 270 shallow wells located in Chautauqua County, most of which are used by the owners of the wells for their own consumption. The number of gas wells drilled in 1910 was 117, of which 97 were productive and 20 were dry holes.

Record of natural-gas industry in New York, 1897–1910.

Year.	Gas produced.		Gas consumed.			Wells.		
	Number of producers.	Value.	Number of consumers. Domestic.	Number of consumers. Industrial.	Value.	Drilled. Gas.	Drilled. Dry.	Productive Dec. 31.
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 89,837	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	1,340
1910	273	1,678,720	106,538	1,058	3,963,872	97	20	1,411

a Number of fires supplied.

Depth and gas pressure of wells in New York, 1907–1910, by counties.

County.	Depth, in feet.	Pressure, in pounds. 1907	1908	1909	1910
Allegany	600–1,700	10–150	10–200	6–300	10–300
Cattaraugus	400–2,300	5– 85	4–150	8–250	10– 90
Chautauqua	150–2,471	1–800	1–800	0–800	1–700
Erie	360–2,980	40–585	25–500	25–500	22–610
Niagara	550	....	150	150	....
Genesee	1,150–1,850	300–580	600	600	500
Livingston	345–2,000	10	1–350	15–450	10–380
Monroe	550–1,025	....	....	....	....
Onondaga	1,000–3,000	100	100–350	....	300–500
Ontario	650–2,300	65–425	65–510	60–480	5–400
Seneca	1,450–1,550				
Oswego	700–1,300	....	....	3–200	20–200
Schuyler	1,000–1,400	100–435	15–100	100–435	100–435
Yates	1,200–1,900				
Steuben	279– 850	....	25	....	50–100
Wyoming	1,638–1,913	140–200	100–200	200	50

WEST VIRGINIA.

Returns received from producers show that in both 1909 and 1910 West Virginia produced more gas in quantity than any other State, but took the lead in the value of gas produced for the first time in 1910, displacing Pennsylvania which heretofore has been the banner State. This was the result of the greater quantity of gas piped from the State by the large gas companies to consumers in the cities and towns of Pennsylvania, Ohio, Maryland, and Kentucky.

The total quantity of gas produced in West Virginia in 1910 was 190,705,869,000 cubic feet, valued at $23,816,553, as compared with 166,435,092,000 cubic feet, valued at $17,538,565, in 1909. The average price received per thousand cubic feet for gas produced was 10.54 cents in 1909 and 12.49 cents in 1910, an increase of 1.95 cents.

As has already been stated in previous reports, much of the gas produced in West Virginia is sold at a flat rate and used within the State for both domestic and industrial purposes without being metered, and hence the quantity of gas consumed can only be estimated.

During the year 1910 a quantity estimated at 20,300,644,000 cubic feet, and valued at $470,924, was consumed in the manufacture of carbon black, an industry extensively carried on in this State. These figures are only approximate, as most of the gas consumed was not measured. Another industry, which may assume importance in this State in the near future, is the extraction of gasoline from surplus gas from the oil wells. A few plants are already in operation and others are being erected, but no available statistics could be obtained for 1910.

Drilling operations were unusually active in West Virginia in 1910, there being a total of 952 wells completed, of which 883 were gas and 69 were dry holes, the total number of productive gas wells at the close of the year being 3,775.

Record of natural-gas industry in West Virginia, 1897–1910.

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 45,943	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
1910	241	23,816,553	86,778	2,823	b 5,617,910	883	69	3,775

a Number of fires supplied. b Includes gas consumed in Maryland.

Depth and gas pressure of wells in West Virginia, 1907–1910, by counties.

County.	Depth, in feet.	Pressure, in pounds.			
		1907	1908	1909	1910
Braxton	2,250–3,000				
Clay	1,650–1,992	250–900	250–500	240–525	125–535
Taylor	2,100				
Brooke	1,200–1,700	100	30–600	100–600	100–400
Cabell	900–2,325	300–625	230–650	200–460	250–540
Calhoun	824–4,000	200–600	25–400	60–1,400	18–1,500
Doddridge	1,650–3,000	180–620	70–580	100–800	10–760
Gilmer	1,280–2,873	....	....	250–875	350–630
Hancock	700–1,400	15–300	1–220	10–150	3–100
Harrison	800–3,092	105–975	150–800	50–900	50–900
Kanawha	1,500–2,585	....	....	500	480–560
Lewis	1,510–3,000	250–900	275–750	200–720	125–800
Lincoln	1,200–2,720	500	585	250–450	400–500
Marion	1,500–3,207	300–350	100–700	125–580	50–600
Marshall	1,000–2,900	....	160–300	200–300	10–295
Monongalia	1,350–3,500	140–450	40–400	85–500	70–450
Pleasants	900–2,001	50–300	200–350	100–250	100–150
Putnam	900–2,400	....	....	300–800	300–800
Upshur	2,000–2,800	....	....		
Ritchie	915–2,200	....	25–670	45–670	20–800
Roane	1,472–2,350	340	500–700	400–500	275–600
Tyler	1,650–2,700	160–550	40–340	65–300	35–440
Wetzel	2,000–3,375	125–242	65–300	95–250	70–300
Wirt	500–1,800	20–530	30–500	40–500	35–500
Wood	1,080–1,635	....	40–150	250–540	250–540

KENTUCKY.

While the production of gas in Kentucky seems to be decreasing, the consumption of gas within the State is increasing, consumers being supplied with gas from the fields of West Virginia. During the year 1910 Covington and vicinity was supplied with gas from West Virginia, as well as Ashland, Catlettsburg, Louisa, Inez, Russell, Buchanan, Kinner, Warfield, and Kavanaugh.

The production of gas in Kentucky in 1910 amounted to 1,356,771,000 cubic feet valued at $456,293, as compared with 2,097,471,000 cubic feet in 1909, valued at $485,192.

The total number of productive gas wells in this State at the close of 1910 was 217, of which 23 were drilled during the year.

Record of natural-gas industry in Kentucky, 1906–1910.

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
1910	47	456,293	27,961	112	908,293	23	12	217

OHIO.

Ohio, which depends upon the gas fields of West Virginia for the greater portion of its gas supply, piped more gas from West Virginia in 1910 than in any previous year, although a portion of its supply was piped from adjacent gas fields in Pennsylvania. Ohio was second in point of consumption of gas in 1910 as in 1909, the total consumption being 108,074,660,000 cubic feet, valued at $21,210,965, as compared with 97,867,180,000 cubic feet, valued at $18,884,312, in 1909. This increase was due to the greater consumption of gas for domestic purposes, the quantity so consumed in 1910 being 60,539,597,000 cubic feet, valued at $15,145,537, and in 1909 50,356,496,000 cubic feet, valued at $13,503,091.

On the other hand, although there was considerable activity in drilling operations and some good wells were completed, the production of gas in Ohio declined from 53,222,619,000 cubic feet, valued at $9,966,938, in 1909 to 48,232,406,000 cubic feet, valued at $8,626,954, in 1910.

During 1910 a total of 668 wells was drilled, of which 466 were gas and 202 were dry holes, the total number of productive gas wells in this State being 4,375 at the close of 1910. From information received regarding pressure of gas in the various fields of this State in 1910 it was ascertained that the average rock pressure on 35 wells in the new Ashland-Lorain gas field, comprising Ashland, Medina, Richland, Lorain, and Wayne counties, was 663 pounds on December 31, 1910. In the Homer field of Knox and Licking counties the average rock pressure on 286 wells was 207 pounds on December 31, 1910, an approximate decrease in rock pressure on these wells of 40 per cent during the year 1910. In the Sugar Grove field, of Fairfield and Hocking counties, the average rock pressure on 77 wells on December 31, 1910, was 125 pounds, an approximate decrease in rock pressure on these wells of 50 per cent for the year 1910.

Record of natural-gas industry in Ohio, 1897–1910.

Years.	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 4,260
1910	c 1,630	8,626,954	475,505	3,804	21,210,965	466	202	d 4,375

a Number of fires supplied.
b Exclusive of complete report of shallow wells.
c Includes 735 producers in Ashtabula, Huron, Lake, Lorain, and Cuyahoga Counties having shallow wells for their own domestic purposes in 1908, 1,239 in 1909, and 1,289 in 1910.
d Includes 901 shallow wells located in Ashtabula, Huron, Lake, Lorain, and Cuyahoga Counties in 1908, 1,568 in 1909, and 1,541 in 1910.

Depth and gas pressure of wells in Ohio, 1907–1910, by counties.

County.	Depth, in feet.	Pressure, in pounds.			
		1907	1908	1909	1910
Allen	1,200–1,300	200			
Ashland					a 663
Ashtabula	500–2,030		3–300	5–300	5–300
Athens	450–1,500	100	30–250	160–280	25–350
Auglaize	1,110–1,225	5–250	5–225		12– 30
Belmont	1,100–1,824	200–275	5–100	200–300	60–600
Carroll	950–1,434	200–375	200–350	165–300	185–350
Columbiana	575– 900	70–240	30–275	50–287	55–240
Cuyahoga	500–1,300		90	2–100	2– 80
Darke	850–1,300	75–103	30	5– 25	15–185
Fairfield	1,900–2,600	40–130	5–150	60–500	50–289
Guernsey	1,000–1,311	400	300–450	80–400	50–300
Hancock	1,100–1,400	85	3– 5	2– 70	2– 50
Hardin	1,260–1,460		16–150	25– 40	20–300
Harrison	703–1,630	40–200	5–125	5–400	30–345
Hocking	2,300–3,300			800–850	
Holmes	600–1,000	215	180–205	225	
Jefferson	600–2,026	240	150–495	40–230	40–250
Knox	590–3,000	110–400	140–900	25–400	80–390
Lake	500–1,560		100	1–100	1–135
Licking	2,100–2,900	200–750	100–730	100–750	80–600
Logan	1,385–1,460	40		130–280	
Lorain	338–2,590		0–120	0–840	0–500
Lucas	1,165–1,550	1– 90	1– 80	8– 30	4– 11
Medina	250–1,300		20– 75	10– 40	3– 30
Mercer	1,096–1,400	2– 40	2–250	4–210	1–150
Monroe	650–2,400	400	200–500	25–500	60–400

a Average.

Depth and gas pressure of wells in Ohio, 1907–1910, by counties—Continued.

County.	Depth, in feet.	Pressure, in pounds.			
		1907	1908	1909	1910
Morgan	250–1,650	15– 500	20– 450	10– 400	20–450
Muskingum	800–3,350	400– 425	350– 400	1,000–1,100	....
Noble	484–2,000	....	550	150– 700	100–500
Ottawa	1,250–1,600	50– 420	20– 400	100– 350	200–450
Perry	1,200–3,448	350– 700	75– 85	50– 900	40–740
Richland	1,950 2,650	1,100	500–1,000	450	250–400
Sandusky	470–1,400	30– 75	20– 200	40– 160	5–175
Seneca	370–1,760	15– 140	2– 150	50– 175	25–100
Trumbull	370– 388	....	75	....	....
Tuscarawas	1,000	....	....	....	325–385
Van Wert	1,200–1,285	....	175	35	40
Vinton and Jackson	520– 800	300	275– 325	250	....
Warren	275–1,000	....	40– 50	....	....
Washington	700–2,600	75– 350	15– 550	15– 450	15–500
Wood	1,175–1,500	20	....	....	20– 40

INDIANA.

No new gas fields were reported in Indiana in the year 1910 and there has been no improvement in the gas industry of this State since the report for 1909. The wells show decreasing volume and pressure and both the quantity and the value of gas produced in 1910 were less than in 1909, amounting to 5,760,252,000 cubic feet, valued at $1,473,403, in 1910, and to 6,159,029,000 cubic feet, valued at $1,616,903 in 1909.

In the year 1910 a total of 102 wells was drilled in Indiana, 69 of which were productive. The total number of productive wells was 2,705 at the close of 1910.

Record of natural-gas industry in Indiana, 1897–1910.

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
1910	1,027	1,473,403	36,054	282	[b] 1,473,403	69	33	2,705

[a] Number of fires supplied. [b] Includes value of gas consumed in Chicago, Ill.

Depth and gas pressure of wells in Indiana, 1907-1910, by counties.

County.	Depth, in feet.	Pressure, in pounds.			
		1907	1908	1909	1910
Adams	1,000-1,050			250	
Bartholomew	864- 990	5- 150	100-150	50-175	50-250
Blackford	850-1,080	1- 65	2- 60	1- 25	1- 10
Clark	128- 244		10- 27		
Daviess Martin	400- 600	8- 25	5- 50	0- 20	0- 60
Decatur	725-1,000	15- 335	10-335	0-325	0-315
Delaware	728-1,200	1- 40	1- 75	1- 55	0- 70
Grant	830-1,100	*a* 0-*b* 240	45	2- 45	2- 50
Hamilton	800-1,200	10- 175	10-190	5-185	15-180
Hancock	700-1,100	5- 140	5-250	0-100	0-100
Harrison	320- 404	60	40		
Henry	800-1,100	15- 120	5-270	5-100	0- 90
Howard	800-1,100	25- 250	3-240	0-200	0-220
Jay	900-1,417	160	60	0- 50	0- 40
Jefferson	1,360		8- 10		
Madison	800-1,100	1- 200	1-150	0-200	0-190
Miami	900-1,000	20- 60	20-100	0- 10	0- 40
Marion Ripley	950-1,000	60- 190		35	40
Pike	1,000-1,400		250-525	300-550	125-500
Randolph	900-1,300	5- 260	1-220	0-175	0-180
Rush	780-1,035	25- 350	10-350	9-375	20-325
Shelby	750-1,000	45- 350	25-330	10-310	1-375
Spencer	950-1,000			Less than	
Sullivan	721- 750	295	295	285-390.	
Tipton	750-1,100	40- 200	10-180	18-180	10-230
Wayne	800-1,150	50- 80	50-250	20-300	50-240

a Run on vacuum. *b* New.

ILLINOIS.

The condition of the natural-gas industry was practically the same in Illinois in 1910 as in 1909. The returns show a slight decline in output and value of gas produced. The total quantity of gas produced in 1910 amounted to 6,723,286,000 cubic feet, valued at \$613,642, as against 8,472,860,000 cubic feet in 1909, valued at \$644,401. The larger portion of this gas was utilized for industrial purposes, principally for the operation of engines and boilers in the fields.

With the exception of Bond County, no new developments were reported in 1910. In Bond County three gas wells have been drilled, the product of which is used to supply Greenville. Other cities and towns supplied in 1910 were Heyworth, supplied from wells in McLean County; Carlinville, supplied from wells in Macoupin County; Vincennes, Ind., supplied from wells in Crawford County; Bridgeport, Casey, Olney, Lawrenceville, Sumner, New Hebron, Oblong, Palestine, Stoy, Duncansville, Flatrock, Birds, Pinkstaff, Hutsonville, Annapolis, Porterville, Robinson, Marshall, and Martinsville, supplied with gas from wells in Crawford, Clark, Cumberland, and Lawrence counties.

The number of productive gas wells in Illinois at the close of 1910 was 435, of which 64 were drilled in 1910. During the year 1910 52 gas wells were abandoned.

Record of natural-gas industry in Illinois, 1906–1910.

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	423
1910	207	613,642	a 10,109	a 479	a 613,642	64	31	435

a Includes number of consumers and value of gas consumed in Vincennes, Ind.

Depth and gas pressure of wells in Illinois, 1908–1910, by counties.

County.	Depth, in feet.	Pressure, in pounds.		
		1908	1909	1910
Bureau	105– 330	0– 30	0– 23	0– 23
Champaign	80– 130	....	....	15– 32
Clark	250– 550	65–100	38–100	35– 45
Crawford	500–1,550	25–400	45–275	20–225
Cumberland	500– 575	15– 35	40	....
Dewitt	94– 120	....	....	25– 50
Edgar	265– 600	....	....	75–127
Lawrence	1,400–1,652	500–600	200–580	200–750
Lee	175– 280	....	....	18– 28
Pike	100– 893	3– 10	3– 7	4– 10

KANSAS.

The report shows that among the States Kansas stands third in the quantity of gas produced in 1910, as in 1909. The production of gas in this State in 1910 amounted to 59,380,157,000 cubic feet, valued at $7,755,367, as against 75,074,416,000 cubic feet in 1909, valued at $8,293,846, a decline in both output and value in 1910. This decreased output and the consequent requirements of consumers in Kansas and Missouri, which State has been dependent upon the gas fields of Kansas for its supply, are amply provided for by the pipeage of gas from the fields of Oklahoma, from which State considerable gas was piped in 1910. The total consumption of gas in Kansas and Missouri in 1910 amounted to 81,929,740,000 cubic feet, valued at $9,163,863, as against 77,887,458,000 cubic feet, valued at $8,356,076 in 1909. The greater portion of the gas consumed in Kansas was utilized for industrial purposes. It is estimated that the consumption of gas at zinc smelters in Kansas in 1910 amounted to 16,992,589,000 cubic feet, valued at $604,604; the gas consumed at cement plants amounted to 10,726,940,000 cubic feet, valued at $530,060; the consumption of gas at brick and glass works was 4,384,019,000 cubic feet, valued at $209,318. Much of this gas was not metered, and the figures given are considered approximate. The total value of gas consumed for domestic purposes in 1910 was $5,202,914, as compared with $4,923,702 in 1909, the average price per thousand cubic feet being 21.9 cents in 1910 and 20.6 cents in 1909.

The report shows that 587 wells were drilled in Kansas in 1910, of which 392 were productive and 195 were dry. A total of 423 wells were abandoned during the year, the number of productive gas wells at the close of the year being 2,107.

Record of natural-gas industry in Kansas, 1897–1910.

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
1910	204	7,755,367	185,972	1,228	c 9,163,863	392	195	2,107

a Number of fires supplied.
b Includes gas taken from Kansas and consumed in Missouri.
c Includes gas taken from Kansas to Missouri; also gas piped from Oklahoma to Kansas.

Depth and gas pressure of wells in Kansas, 1907–1910, by counties.

County.	Depth, in feet.	Pressure, in pounds.			
		1907	1908	1909	1910
Allen	600–1,300	10–300	5–300	5–300	15–350
Anderson	230– 765	43–200	65–237	65–200	40–150
Bourbon	200– 710	50	50	75	35– 45
Chase	150– 580	48–100	6–150	17–300	10–350
Crawford, Cowley	150– 800	25–150	20– 26	55– 80	4– 65
Chautauqua	325–1,300	50–280	50–260	60–500	40–500
Douglas, Johnson	335– 675	60–230	5–170	40–180	10–100
Elk	500–1,278	10–300	100–215	40–200	100–225
Butler, Greenwood, Woodson	365–1,450	75–450	40–640	40–500	40–550
Labette	450–1,000	80–200	80–208	60–125	50–160
Linn	200– 600	9–175	10–175	10–150	12–130
Franklin, Miami	160– 750	20–225	20–260	20–200	75–210
Montgomery	258–1,600	25–530	40–530	10–350	3–295
Neosho	490–1,200	40–225	50–250	25–350	35–300
Wilson	670–1,300	70–395	50–395	25–400	12–400
Wyandotte	271– 635	175	160–198	150–250	50–200

MISSOURI.

The natural-gas situation in Missouri remains unchanged. The gas wells of the State are all shallow, ranging in depth from 100 to 460 feet. At the close of the year 1910 there were 49 gas wells in the State, the majority of which were used by the owners of the wells for their own consumption. A few wells were used to supply domestic consumers in Belton, Cass County, and Rich Hill, Bates County. The gas wells of this State are located in Cass, Bates, and Jackson counties.

The total value of the gas consumed in the State in 1910 was $12,611.

OKLAHOMA.

Since the annulment, early in 1909, of the State law prohibiting the pipeage of gas from Oklahoma, the development of the natural-gas industry of this State has progressed with great rapidity. During the year 1910 a total of 151 wells was drilled, of which 93 were productive of gas and 58 were dry holes, making the total number of gas wells 502 at the close of the year. Many of these wells are of large volume, and at the present time millions of feet of gas are closed in, awaiting a market. However, a considerable quantity of gas was piped out of the State in 1910, supplying domestic consumers and zinc, cement, and other industrial plants in Kansas and domestic consumers and mines and mills of the Joplin district, Missouri.

The total quantity of gas produced in Oklahoma in 1910 was 50,429,646,000 cubic feet, valued at $3,490,704, as compared with 28,036,976,000 cubic feet, valued at $1,806,193, in 1909, the gain in production and value being nearly 100 per cent. The total quantity of gas consumed in the State of Oklahoma in 1910 was 27,880,063,000 cubic feet, valued at $2,082,208, as against 25,223,934,000 cubic feet, valued at $1,743,963, in 1909. The average price of gas per thousand cubic feet consumed in the State in 1910 was 7.46 cents, as compared with 6.91 cents in 1909. The greater portion of the gas utilized in the State in 1910 was consumed for industrial purposes, amounting to 22,482,779,000 cubic feet, valued at $1,169,250, the quantity of gas consumed for domestic purposes aggregating 5,397,284,000 cubic feet, valued at $912,958.

Record of natural-gas industry in Oklahoma, 1906–1910.

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	454
1910	168	3,490,704	38,978	2,059	2,082,208	93	58	502

[a] Includes 87 wells "shut in" in 1907. [b] Includes 100 wells "shut in" in 1908.

Depth and gas pressure of wells in Oklahoma, 1908–1910, by counties.

County.	Depth, in feet.	Pressure, in pounds.		
		1908	1909	1910
Carter	700– 900			
Cherokee	600– 650	190–200	50–350	60–100
Comanche	380– 400			
Creek	895–2,500	60–900	50–900	40–450
Kay	500– 997	75–481	60–385	60–375
Kiowa	380– 640	50–150	....	35
Leflore	1,700	....	....	350
Muskogee	1,055–1,865	470–650	130–160	50–500
Nowata	500–1,700	100–450	120–500	70–100
Okmulgee	760–2,090	300–800	150–700	150–800
Osage	1,500–2,010	300–850	300–850	200–650
Pawnee	1,200–1,698	200–400	160–260	150–200
Rogers	380–1,250	110–320	50–550	125–530
Tulsa	580–1,742	50–700	50–700	50–650
Wagoner	750–1,692	350–600	210–600	90–120
Washington	453–2,260	40–700	60–800	80–740

ALABAMA.

At the close of the year 1910 there were in the State of Alabama 18 gas wells, 5 of which were completed in that year. These wells are located in Fayette, Madison, Mobile, and Walker counties. The only wells whose product was utilized in 1910 were those in Fayette and Madison counties. Ninety-five domestic consumers were being supplied at the close of 1910, and some gas was being utilized for power in the field. Several wells are in process of drilling, with the expectation of developing an oil or gas field of importance.

The statistics of gas production of Alabama in 1910 are included with those of Louisiana and Texas.

ARKANSAS.

Although no new gas fields were reported as having been discovered in this State in 1910, considerable work was done in the older fields. During 1910 a total of 47 wells were drilled, of which 37 were productive, making the total number of gas wells in this State at the close of the year 103.

The statistics of the natural-gas industry of this State have been included with those of Colorado and Wyoming.

LOUISIANA.

Although some gas wells of exceptional size have been completed in the State of Louisiana in the last few years, the development of this industry does not progress as rapidly as was expected. The gas consumed is chiefly produced from wells located in the Caddo field, Caddo Parish, although a small production is reported from wells located in Lafourche Parish. At Naborton, 9 miles east of Mansfield, in De Soto Parish, a gas strike of considerable importance was made at a depth of about 850 feet, the pressure being 270 pounds. It is reported that the gas from this well will be utilized for fuel to drill other wells in the locality.

The main feature of interest in the natural-gas industry of Louisiana was the effort to check the flow of the wild gas wells in the Caddo field, and this was accomplished soon after the close of the year for the western one of the two wild wells. This was done by drilling an additional well near the wild well and forcing water through it so as to drown out the gas from the first well. The operation was comparatively simple and effective, and was carried out under the supervision of Mr. S. S. Hunter. No further progress was made in developing a pipe line for natural gas either for St. Louis or for New Orleans.

Most of the gas produced in Louisiana is piped out of the State to supply consumers in Texas and Arkansas. During the year 1910 Texarkana, Ark., and Texarkana, Tex., were wholly supplied; also Marshall, Atlanta, and Queen City, Tex. The cities and towns supplied with gas in Louisiana are Blanchard, Mooringsport, Caddo, Rodessa, Oil City, Vivian, Bloomburg, Ravenna, Shreveport, Bossier, Dixie, and Belcher.

At the close of the year 1910 there were 91 gas wells in this State, of which 23 were drilled in 1910.

The statistics of the gas industry of this State are included with those of Texas and Alabama.

TEXAS.

Texas is beginning to assume importance as a gas producer. The principal gas-producing sections of the State are located in Clay and Navarro counties. During 1910 gas was discovered in Webb County and preparations have been made to supply the town of Laredo from this field. It is also reported that gas has been discovered in Coleman County, but whether of commercial value has not been ascertained. Considerable gas is produced from oil wells in this State and consumed for development and operating purposes in the field.

The principal gas companies of the State in 1910 were the Lone Star Gas Co., operating in Clay County, and the North Texas Gas Co., operating in Navarro County. The gas from these fields is supplied to the following-named places: Fort Worth, Dallas, Wichita Falls, Henrietta, Petrolia, Byers, Bellevue, Bowie, Sunset, Decatur, Alvord, Rhome, Bridgeport, Irving, and Corsicana, all in Texas. As already stated in this report, some of the gas consumed in Texas is piped from wells in the Caddo field, the cities of Marshall, Texarkana, Atlanta, and Queen City being thus supplied.

The total number of gas wells in Texas at the close of 1910 was 59, of which 22 were completed in 1910.

The statistics of the consumption of gas in Texas are included with those of the States of Louisiana and Alabama.

Use of natural gas for locomotives.—In the year 1910 natural gas was used in Texas for fuel, on a short railroad about 7½ miles long, running from Bloomberg, on the Kansas City Southern Railroad, to Atlanta, there being a natural gas line at each end of the road. It was demonstrated that steam could be raised quicker with the gas than with coal and would haul the same load, but the results were not entirely satisfactory on account of the increased danger to the trainmen and because the pressure of the gas was not high enough in the pipe line to give the pressure that was required in the drum.

A gas drum, or tank, 6 feet in diameter and 36 feet long, was loaded on a flat car, which was coupled to the rear of the locomotive, and connected by pipes with the fire box. A burner having 36 openings through which the gas escaped as it was used, was placed on the grate bars with about 6 inches space between the burner and the walls of the box. Gas was charged into the tank with natural gas pressure, which was about 100 pounds, and was then connected to the gas burner in the fire box and regulated by a valve in the cab, which was handled by the fireman.

The gas was used successfully for about 5 months, but at the end of that time an inexperienced fireman was put on, and while stopping at one of the stations, instead of cutting the gas down, which was what he should have done, he made a mistake and turned the gas on. The fire door was kept in the second notch, which permitted the fireman to see inside and know how the combustion was, and the gas also seemed to burn better with the door open this much. When the fireman turned the gas on instead of turning it off, the blaze came out of this space at the door and filled the cab with flames. Both the fireman and the engineer jumped off and the latter shut off the gas at the tank. Neither of the men were seriously burned. After this the gas was used successfully for at least 30 days. In the meantime the company decided that it would not like to run the risk of this happening again and would discontinue the use of gas and return to coal.

SOUTH DAKOTA.

The gas produced in South Dakota comes from artesian wells located in Hughes, Lyman, Stanley, Sully, and Walworth counties. Most of the gas consumed is utilized by the owners of the wells for their own consumption. However, there are in Pierre and Fort Pierre a few wells, whose gas product is supplied to domestic consumers in these towns, as well as used for power by the water and electric-light plants of the city of Pierre.

The total value of the gas consumed for all purposes in South Dakota during the year 1910 amounted to $31,999.

COLORADO.

No developments of importance have been reported in the natural-gas situation in Colorado in 1910. The principal gas production of the State is from a well in the Boulder field, the product of which is being supplied to domestic consumers in the town of Boulder. A considerable quantity of gas is produced from the oil wells of the Boulder and Florence fields of this State. During the year 1910 a plant compressor for the purpose of extracting gasoline from natural gas from one of the wells in the Boulder field was completed and put into operation, and another plant was being installed in the same field. The gas produced from the oil wells of this State is used for field purposes.

The statistics of gas consumed in Colorado in 1910 are included with those of Arkansas and Wyoming.

WYOMING.

The quantity of gas consumed during 1910 in Wyoming was produced from wells located in Bighorn, Converse, and Uinta counties. The principal producer of the State is the Big Horn Oil & Gas Co., from whose wells consumers in the towns of Greybull and Basin are supplied.

The number of gas wells drilled in this State in 1910 was 12, of which 6 were dry holes, the total number of productive wells at the close of the year being 20.

The statistics of consumption of gas in Wyoming have been consolidated with those of Colorado and Arkansas.

CALIFORNIA.

The report shows an increase in the production of gas in California in 1910, as compared with previous years, and the probability is that this increase will continue on account of the new discoveries recently made. In the Midway district of Kern County 4 gas wells of high pressure and large capacity had been completed at the close of 1910, and although the gas from these wells was used to some extent for field purposes preparations were in progress to pipe the gas to towns in the neighborhood of the wells. It is reported that Bakersfield and Fellows are to be supplied, and Taft and Maricopa are now being supplied. Many of the oil wells in California produce sufficient gas to operate the wells, and some have gas to supply neighboring leases both for drilling and operating, as well as to supply a few domestic consumers in the vicinity of the wells.

Early in the year the exploration for oil to the east of the South Midway field developed some unusually large gas wells in the Buena Vista Hills. Near the close of the year these wells were gotten under control, and active steps were taken for piping the gas to Bakersville. There is every indication that gas will be eventually piped down the San Joaquin to Fresno, and thence to San Francisco in one direction and to Los Angeles in the other.

The total production of gas in California was estimated at 2,764,507,000 cubic feet in 1910, valued at $476,697, of which 245,738,000 cubic feet, valued at $194,631, was supplied to domestic consumers, and 2,518,769,000 cubic feet, valued at $282,066 was supplied to industrial consumers. The gas supplied for industrial purposes was chiefly the product of the oil wells and was utilized for drilling and pumping in the field.

The number of gas wells in California at the close of 1910 was 55, 3 gas wells having been drilled during the year. The number of gas wells abandoned in 1910 was 12.

NORTH DAKOTA.

As compared with previous reports the development of the gas industry of North Dakota shows considerable progress. During the year 1910 the value of the gas produced from wells and consumed in this State was $7,010. At the close of 1910 consumers in the towns of Lansford and Westhope were being supplied with gas from wells located in Bottineau County. With the exception of one well in this county, which is about 2,000 feet deep, the wells are all shallow, ranging from 170 to 300 feet. Gas was also produced from artesian wells in Lamoure County in 1910, and was used for domestic consumption by the owners of the wells.

IMPORTS.

The imports of natural gas for consumption during the last six years have been as follows:

Value of natural gas imported for consumption, 1905–1910.

1905	$49,237	1908	$22,003
1906	36,906	1909	6,060
1907	32,107	1910	(a)

[a] No imports reported for 1910.

No exports of natural gas during 1907, 1908, 1909, and 1910 were reported.

NATURAL GAS IN FOREIGN COUNTRIES.

CANADA.

The following table gives the value of natural gas produced in Canada each year since 1892:

Value of natural gas produced in Canada, 1892–1910.

Year.	Value.	Year.	Value.	Year.	Value.
1892	$150,000	1899	$387,271	1906	$583,523
1893	376,233	1900	417,094	1907	815,032
1894	313,754	1901	339,476	1908	1,012,660
1895	423,032	1902	195,992	1909	1,207,029
1896	276,301	1903	202,210	1910	1,491,239
1897	325,873	1904	328,376		
1898	322,123	1905	379,561		

Ontario.—The Twentieth Annual Report of the Bureau of Mines, Toronto, states that while the production of petroleum is declining, the production of natural gas is increasing. In 1909 the output of natural gas was valued at $1,188,179, and in 1910 it was $1,491,239, an increase of $303,060, or 25.5 per cent. The quantity of gas produced in 1910 is given as 7,263,427,000 cubic feet, so that the average price at which the yield was valued is 20.5 cents per thousand cubic feet.

The gas-producing territory of Ontario lies on the north and east shores of Lake Erie. The several fields have been steadily extending, and appear likely to cover practically the whole of the Ontario side of the lake. At present there are three separate fields, namely, Welland County, Haldimand and Norfolk counties, and Essex and Kent counties. The last named field was the largest producer in 1910, the Haldimand-Norfolk field next, and Welland County the smallest.

In the following table are given the statistics of the natural-gas business in Ontario in the year 1910:

Statistics of natural-gas production in Ontario in 1910.

Field.	Producing wells.	Wells bored in year.		Miles of pipe.	Employees.	Wages paid.	Gas produced, M cubic feet.	Value.
		Producing.	Nonproducing.					
Welland	337	33	8	401	67	$40,411	1,047,463	$278,756
Haldimand-Norfolk	444	103	21	400	71	43,315	2,374,730	676,986
Essex-Kent	47	9	1	181	48	35,059	3,841,234	535,497
Total	828	145	30	982	186	118,785	7,263,427	1,491,239

These figures show that the yield per well was very much greater in the Essex-Kent field than in any of the others, also that the price per thousand cubic feet obtained for the product in that field was considerably less than in either of the others, the average price per thousand being 26.6 cents in Welland, 28.5 cents in Haldimand-Norfolk, and 13.9 cents in Essex-Kent. The consumption of gas in the Haldimand-Norfolk field is largely confined to domestic purposes, being piped to Hamilton, Dundas, Brantford, Galt, and other places. The leading producer will sell only for household use.

The producing gas wells drilled in 1910 are distributed by counties as follows: Haldimand, 159; Welland, 34; Brant, 21; Norfolk, 11; Wentworth, 5; and Elgin, 2. From the new gas field at Middleport a new 4-inch main line has been laid across the Indian Reserve to the city of Brantford by the Standard Natural Gas Co. Two first-class wells have been drilled at Vienna, and the prospects for the development of a new field here are particularly good for 1911.

The main features in connection with the natural-gas industry in the Province in 1910 have been the further development of the Welland-Haldimand-Norfolk field, which may now be regarded as one, the discovery of a new productive area in Elgin County, and increased production from the Kent field.

In the Welland-Haldimand-Norfolk field, which is the oldest and most extensive in area, stretching as it does along Lake Erie for about 90 miles and having a depth of probably 2 to 3 miles, the development has consisted principally in successful drilling in certain portions which have hitherto been regarded as unproductive or of little value. The field was also extended somewhat to the west.

The newly found field in Elgin County is in the township of Bayham. Only a few wells had been drilled up to April, 1911, and consequently no reliable estimate can be formed of the probable production from this field.

No extensions have been made in the area of the Kent field, although the production of gas has increased rapidly.

Statistics of natural-gas production in the Province of Ontario, Canada, 1902–1910.

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	2,534,200,000	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
1910	828	982	186	7,263,427,000	1,491,239	118,785

GERMANY.

The United States consul-general at Hamburg has furnished additional details with reference to the natural gas discovered in 1910 at Bergedorf, in the vicinity of Hamburg. The quantity of gas now escaping from this well is nearly 20,000,000 cubic feet a day. The variation has been very slight since the discovery of the deposit in November, 1910. The well is 808 feet deep and is located on property which had been leased to the State of Hamburg, and was obtained in drilling for a city water supply.

HUNGARY.

During the year 1910 interest in the natural-gas deposit at Kissarmas has been increased by the investigations of government geologists and engineers. It is proposed to constitute this natural gas a government monopoly, and to pipe it to near-by towns and villages for the development of various industries.

The government engineers estimate that of the yield there will be sufficient gas to illuminate all the towns and villages in Transylvania, and also to bring over by pipes large quantities of gas to Budapest. Other borings for gas have already been commenced at Dieso-Szent-Marton, Ura Maros-Szent-Gyorgy, Sashsich-Regen, and Szent-Benedek.

ITALY.

The Rivista Minerario gives the production and value of natural gas in Italy from 1903 to 1910, as follows:

Production and value of natural gas in Italy, 1903–1910.

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
1910	8,840,000	73,301

UNITED KINGDOM.

The annual report of the British home office gives the statistics of the production and value of natural gas in the United Kingdom for the years 1902 to 1910, as follows:

Production and value of natural gas at Heathfield,[a] England, 1902–1910.

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)
1910	(d)	....

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.
d Not available.

PETROLEUM.

By David T. Day.

INTRODUCTION.

The petroleum industry in the United States has been characterized by a phenomenal increase each year for the last four years. Each gain over the previous one has been so remarkable as to lead to the belief that the limit had been reached, especially as petroleum is a commodity which should ordinarily keep pace with population. But on the contrary the product has increased more rapidly and irregularly. Thus, after varying approximately between 50,000,000 and 60,000,000 barrels in the decade between 1890 and 1900, the industry closed the century with an output of over 63,000,000 barrels in 1900, rose to 88,000,000 barrels in 1902, to 100,000,000 barrels in the succeeding year, to 117,000,000 barrels in 1904, and to nearly 135,000,000 barrels in 1905; and after a slight decline in 1906, the output rose again in 1907, reaching 166,000,000 barrels. Since then the growth has continued this phenomenal course to 178,000,000 barrels in 1908, to 183,170,874 barrels in 1909, and it passed the 200,000,000-barrel mark, attaining 209,555,048 barrels in 1910—a gain of 14.4 per cent over the already excessive product of 1909. This has brought the total output since the beginning of the industry in the United States to more than 2,000,000,000 barrels. The excess of the product over the normal demand is shown by the fact that 209,000,000 barrels in 1910 brought a smaller total value ($127,896,328) than 183,000,000 barrels the year before ($128,328,487), and that the smaller product, 178,000,000 barrels in 1908, was valued at still more ($129,079,184). As the production has gone up the average price per barrel has gone down from more than $1 per barrel in 1900 to 73.1 cents in 1906, to 72.3 cents in 1907 and 1908, to 70.1 cents in 1909, and to 61 cents in 1910. The causes of these repeated great increments in production have been the successive development of four great fields to the west of the old productive centers. In 1900 the industry had adapted itself to the influx of oil from western Ohio and Indiana. Then came, in rapid succession, the development of the Gulf field in Texas and Louisiana, of the Mid-Continent field in Kansas and Oklahoma, and then of the Illinois field. In the meantime, California's production has been increasing so rapidly that it has become the dominant center of interest for the last two years, outstripping the production of any other State in 1909 and 1910, and promising to retain this supremacy for future years.

Obviously the trade effect of these developments was greatly discounted by the much lower quality of Texas, Louisiana, and California oils for refining, and it was only when the superior quality of the Mid-Continent oil was recognized that these western contributions began to be taken seriously in the general trade (and the market was to some extent prepared for the sudden addition of the great supply from Illinois). California petroleum is separated by geographical and technical boundaries from the eastern supply; but its great production has compelled such advances in refining methods as to make it reasonably certain that California will in the future yield good refined products, including lubricating and illuminating oil.

Concerning the production of 1910, California increased her output by 31.6 per cent over 1909, and this increase was the statistical feature of the year. Louisiana more than doubled its yield, owing to the Caddo field, and nine States showed the usual decline of old fields. The States west of Ohio produced about 85 per cent of the petroleum, as is made clear by the table on a subsequent page.

Consistently with the increase in production of 26,385,174 barrels, the total stocks increased by 14,343,054 barrels, or to the great total of 131,030,138 barrels. The increase in stocks was almost entirely from California, and it does not include over 4,000,000 barrels of oil in producers' storage that were not sold.

ACKNOWLEDGMENTS.

It is a pleasure to refer again to the hearty cooperation of the petroleum producers of the country from whom one set of production statistics has been obtained, and of the pipe line and other transportation agencies from whose statistics a separate statement has been prepared. The agreement between the results of these two different methods will become closer each year.

In addition, grateful acknowledgment is made of the valuable information furnished by State and other geologists, refining companies, and the technical press—especially the Oil City Derrick, whose field reports have been accepted as authoritative; the Independence Daily Reporter; the Oil and Gas Journal, of St. Louis, whose field reports are accepted for Texas and Louisiana; the Oil, Paint, and Drug Reporter; the Petroleum Gazette; the California Derrick; the California Oil World; the Moniteur du Pétrol Roumain; and the Petroleum Review, of London.

The statistics of production in Illinois, Kansas, and Kentucky were collected from the producers by a cooperative canvass with the State geologists.

PRODUCTION.

The statement of production by States for the years 1909 and 1910 is given in the following table:

Total quantity and value of petroleum produced in the United States and the average price per barrel in 1909 and 1910, by States, in barrels.

State.	1909			1910		
	Quantity.	Value.	Average price per barrel.	Quantity.	Value.	Average price per barrel.
California	55,471,601	$30,756,713	$0.554	73,010,560	$35,749,473	$0.490
Colorado	310,861	318,162	1.023	239,794	243,402	1.015
Illinois	30,898,339	19,788,864	.640	33,143,362	19,669,383	.593
Indiana	2,296,086	1,997,610	.870	2,159,725	1,568,475	.726
Kansas	1,263,764	491,633	.389	1,128,668	444,763	.394
Kentucky	639,016	518,299	.811	468,774	324,684	.693
Louisiana	3,059,531	2,022,449	.661	6,841,395	3,574,069	.522
Michigan Missouri	5,750	7,830	1.362	3,615	4,794	1.326
New York	1,134,897	1,878,217	1.655	1,053,838	1,414,668	1.342
Ohio	10,632,793	13,225,377	1.244	9,916,370	10,651,568	1.074
Oklahoma	47,859,218	17,428,990	.364	52,028,718	19,922,660	.383
Pennsylvania	9,299,403	15,424,554	1.659	8,794,662	11,908,914	1.354
Texas	9,534,467	6,793,050	.712	8,899,266	6,605,755	.742
Utah Wyoming	20,056	34,456	1.718	115,430	93,536	.810
West Virginia	10,745,092	17,642,283	1.642	11,751,871	15,720,184	1.338
Total	183,170,874	128,328,487	.701	209,556,048	127,896,328	.610

Total production of petroleum and percentage of increase or decrease, by States, in 1910, as compared with 1909, in barrels.

State.	Production.		Increase.	Decrease.	Percentage.	
	1909	1910			Increase.	Decrease.
California	55,471,601	73,010,560	17,538,959		31.62	
Colorado	310,861	239,794		71,067		22.86
Illinois	30,898,339	33,143,362	2,245,023		7.27	
Indiana	2,296,086	2,159,725		136,361		5.94
Kansas	1,263,764	1,128,668		135,096		10.69
Kentucky	639,016	468,774		170,242		26.64
Louisiana	3,059,531	6,841,395	3,781,864		123.61	
Michigan Missouri	5,750	3,615		2,135		37.13
New York	1,134,897	1,053,838		81,059		7.14
Ohio	10,632,793	9,916,370		716,423		6.74
Oklahoma	47,859,218	52,028,718	4,169,500		8.71	
Pennsylvania	9,299,403	8,794,662		504,741		5.43
Texas	9,534,467	8,899,266		635,201		6.66
Utah Wyoming	20,056	115,430	95,374		475.54	
West Virginia	10,745,092	11,751,871	1,006,779		9.37	
Total	183,170,874	209,556,048	26,385,174		14.40	

RANK OF PRODUCING STATES.

QUANTITY.

For the first time in many years there was no change in the rank of the principal oil-producing States. As suggested as probable in the preceding report, California produced in 1910 more than twice as much oil as Pennsylvania ever produced in one year.

Rank of petroleum-producing States, with quantity and percentage produced by each, in 1909 and 1910, in barrels.

1909				1910			
State.	Rank.	Quantity.	Percentage.	State.	Rank.	Quantity.	Percentage.
California	1	55,471,601	30.28	California	1	73,010,560	34.84
Oklahoma	2	47,859,218	26.13	Oklahoma	2	52,028,718	24.83
Illinois	3	30,898,339	16.87	Illinois	3	33,143,362	15.82
West Virginia	4	10,745,092	5.87	West Virginia	4	11,751,871	5.61
Ohio	5	10,632,793	5.80	Ohio	5	9,916,370	4.73
Texas	6	9,534,467	5.21	Texas	6	8,899,266	4.25
Pennsylvania	7	9,299,403	5.08	Pennsylvania	7	8,794,662	4.20
Louisiana	8	3,059,531	1.67	Louisiana	8	6,841,395	3.26
Indiana	9	2,296,086	1.25	Indiana	9	2,159,725	1.03
Kansas	10	1,263,764	.69	Kansas	10	1,128,668	.54
New York	11	1,134,897	.62	New York	11	1,053,838	.50
Kentucky	12	639,016	.35	Kentucky	12	468,774	.22
Colorado	13	310,861	.17	Colorado	13	239,794	.12
Wyoming	14	25,806	.01	Wyoming	14	119,045	.05
Michigan	15			Utah	15		
Missouri	16			Michigan	16		
Utah	17			Missouri	17		
Total		183,170,874	100.00	Total		209,556,048	100.00

VALUE.

California led in rank as to value as well as quantity produced, but Oklahoma jumped from fourth place to second, owing to the better transportation facilities to the seaboard afforded by the new pipe line to Baton Rouge, La. The other States kept their rank fairly well.

Rank of petroleum-producing States, with value of production and percentage of each, in 1909 and 1910.

1909				1910			
State.	Rank.	Value.	Percentage.	State.	Rank.	Value.	Percentage.
California	1	$30,756,713	23.97	California	1	$35,749,473	27.95
Illinois	2	19,788,864	15.42	Oklahoma	2	19,922,660	15.58
West Virginia	3	17,642,283	13.75	Illinois	3	19,669,383	15.38
Oklahoma	4	17,428,990	13.58	West Virginia	4	15,720,184	12.29
Pennsylvania	5	15,424,554	12.02	Pennsylvania	5	11,908,914	9.31
Ohio	6	13,225,377	10.31	Ohio	6	10,651,568	8.33
Texas	7	6,793,050	5.30	Texas	7	6,605,755	5.16
Louisiana	8	2,022,449	1.58	Louisiana	8	3,574,069	2.80
Indiana	9	1,997,610	1.55	Indiana	9	1,568,475	1.21
New York	10	1,878,217	1.46	New York	10	1,414,668	1.11
Kentucky	11	518,299	.40	Kansas	11	444,763	.35
Kansas	12	491,633	.38	Kentucky	12	324,684	.25
Colorado	13	318,162	.25	Colorado	13	243,402	.20
Wyoming	14	42,286	.03	Wyoming	14	98,330	.08
Missouri	15			Utah	15		
Michigan	16			Michigan	16		
Utah	17			Missouri	17		
Total		128,328,487	100.00	Total		127,896,328	100.00

PRODUCTION OF PETROLEUM IN THE UNITED STATES FROM 1859 TO 1910, 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 1910:

Production of petroleum in the United States, 1859–1910, 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	55,471,601	[a] 639,016	310,861	2,296,086	30,898,339
1910	9,848,500	9,916,370	11,751,871	73,010,560	[a] 468,774	239,794	2,159,725	33,143,362
Total.	718,292,662	397,658,065	217,059,857	375,302,723	7,112,135	9,804,593	97,866,951	126,593,490

[a] No production in Tennessee recorded.

Production of petroleum in the United States, 1859–1910, 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] 20,056	3,059,531	183,170.874	128,328,487
1910	1,128,668	8,899,266	[a] 3,615	52,028,718	[f] 115,430	6,841,395	209,556,048	127,896,328
Total.	46,551,363	147,460,188	46,082	190,771,142	239,046	44,149,567	2,378,907,864	2,040,808,758

[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.

PRODUCTION BY FIELDS.

In the following tables is given the production of petroleum in the United States for the years 1906 to 1910, inclusive, by fields:

Production of petroleum in the United States, 1906–1910, by fields, in barrels.

Field.	1906	1907	1908	1909	1910
Appalachian	27,741,472	25,342,137	24,945,517	26,535,844	26,891,379
Lima-Indiana	17,554,661	13,121,094	10,032,305	8,211,443	7,253,861
Illinois	4,397,050	24,281,973	33,686,238	30,898,339	33,143,362
Mid-Continent	22,838,553	46,846,267	48,323,810	49,804,922	53,875,072
Gulf	20,527,520	16,410,299	16,272,074	11,912,058	15,022,975
California	33,098,598	39,748,375	44,854,737	55,471,601	73,010,560
Other	336,082	345,190	412,674	336,667	358,839
Total	126,493,936	166,095,335	178,527,355	183,170,874	209,556,048

Percentages of total petroleum produced in the several fields, 1906–1910.

Field.	1906	1907	1908	1909	1910
Appalachian	21.93	15.26	13.97	14.49	12.83
Lima-Indiana	13.88	7.90	5.62	4.48	3.46
Illinois	3.47	14.62	18.87	16.87	15.82
Mid-Continent	18.05	28.20	27.07	27.19	25.71
Gulf	16.23	9.88	9.11	6.50	7.17
California	26.17	23.93	25.13	30.29	34.84
Other	.27	.21	.23	.18	.17
Total	100.00	100.00	100.00	100.00	100.00

Production of petroleum in the United States in 1909 and 1910, by fields, showing increase or decrease, in barrels.

Field.	Production.		Increase.	Decrease.	Percentage.	
	1909	1910			Increase.	Decrease.
Appalachian	26,535,844	26,891,379	355,535	....	1.34	....
Lima-Indiana	8,211,443	7,253,861	....	957,582	....	11.66
Illinois	30,898,339	33,143,362	2,245,023	....	7.27	....
Mid-Continent	49,804,922	53,875,072	4,070,150	....	8.17	....
Gulf	11,912,058	15,022,975	3,110,917	....	26.12	....
California	55,471,601	73,010,560	17,538,959	....	31.62	....
Other	336,667	358,839	22,172	....	6.59	....
Total	183,170,874	209,556,048	26,385,174	....	14.40	....

Quantity, total value, and price per barrel received at wells for petroleum produced in the United States in 1909 and 1910, by fields, in barrels.

Field.	1909			1910		
	Quantity.	Value.	Price per barrel.	Quantity.	Value.	Price per barrel.
Appalachian	26,535,844	$43,237,233	$1.629	26,891,379	$35,838,389	$1.333
Lima, Ind.	8,211,443	7,449,107	.907	7,253,861	5,750,104	.793
Illinois	30,898,339	19,788,864	.640	33,143,362	19,669,383	.593
Mid-Continent	49,804,922	18,314,355	.368	53,875,072	20,769,977	.385
Gulf	11,912,058	8,421,767	.707	15,022,975	9,777,270	.650
California	55,471,601	30,756,713	.554	73,010,560	35,749,473	.490
Other	336,667	360,448	1.071	358,839	341,732	.952
Total	183,170,874	128,328,487	.701	209,556,048	127,896,328	.610

Deliveries of petroleum in the United States and purposes for which shipped in 1910, by fields, in barrels.

Field.	Total deliveries in 1910.	Delivered for—		
		Refining.	Fuel.	Other purposes.
Appalachian	55,477,062	55,437,337	....	[a] 39,725
Lima, Ind	15,977,136	15,958,895	11,295	[b] 6,946
Illinois	18,523,356	18,289,434	233,579	[c] 343
Kansas and Oklahoma	55,440,166	51,817,426	1,961,208	[d] 1,661,532
Louisiana	5,691,837	2,730,224	2,961,613	....
Texas	8,747,145	3,718,339	5,028,670	[a] 136
California	[e] 69,309,555	[e] 15,000,000	[e] 50,809,555	[f] 3,500,000
Other	342,362	273,978	67,878	[a] 506
Total in 1910	229,508,619	163,225,633	61,073,798	5,209,188
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] Road use and gas manufacture.
[c] Street use.
[d] Shipped by rail and can not be classified.
[e] Estimated.
[f] Estimated for gas manufacture.

STOCKS.

The following table gives the stocks of petroleum in the United States in 1910, by fields:

Stocks, runs, and deliveries of petroleum in the United States in 1910, by fields, in barrels.

Field.	Gross stocks, Dec. 31, 1909.	Runs from wells sold or used in 1910.	Deliveries in 1910.	Gross stocks, Dec. 31, 1910.
Appalachian	10,280,655	26,891,379	55,477,062	9,022,152
Lima, Ind	6,432,408	7,253,861	15,977,136	6,579,072
Illinois	29,493,986	33,143,362	18,523,356	[a] 28,084,397
Kansas and Oklahoma	49,629,362	53,157,386	55,440,166	[b] 50,035,523
Louisiana	[c] 669,272	6,841,395	5,691,837	[c] 1,834,775
Texas	[c] 2,169,517	8,899,266	8,747,145	[c] 2,358,840
California	[d] 18,000,000	73,010,560	69,309,555	[d] 33,085,118
Other	11,904	358,839	342,362	30,281
Total in 1910	116,687,104	209,556,048	229,508,619	131,030,158
Total in 1909	....	183,170,874	195,947,188	....
Total in 1908	....	178,527,355	193,459,209	....
Total in 1907	....	166,095,335	172,014,023	....

[a] Includes some Indiana petroleum. Considerable of this petroleum is tanked outside of Illinois.
[b] Includes 1,191,022 barrels of petroleum tanked outside the States of Oklahoma and Kansas.
[c] In addition to this some oil was held in producers' storage and refiners' reserve.
[d] In addition there were field stocks of 1,988,952 barrels in 1909 and 4,156,450 barrels in 1910 held in tanks of producers and unsold.

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 1909 and 1910, 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, 1909 and 1910, by fields, in barrels.

Kind of oil.	Quantity.	
	1909	1910
Pennsylvania	5,511,244	4,667,135
Lima	4,011,233	4,730,409
Illinois	32,343,887	31,324,784
Kentucky	428,390	339,310
Kansas and Oklahoma	53,541,657	52,659,506
Louisiana	669,272	1,834,775
Texas	2,169,517	2,358,840
California	18,000,000	33,085,118
Other	11,904	30,281
Total	116,687,104	131,030,158

Grades of gross stocks of petroleum held by the eastern pipe lines at the close of each month in 1909 and 1910, in barrels.

1909.

Month.	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

1910.

Month.	Pennsylvania.	Lima.	Illinois.	Kentucky.	Kansas.	Total.
January	5,336,369	3,571,056	3,340,116	391,424	4,211,372	16,850,337
February	5,310,711	3,658,944	3,138,018	443,589	4,154,958	16,706,220
March	5,518,850	4,123,514	3,637,610	485,478	3,708,114	17,473,566
April	5,316,652	4,060,064	3,210,907	444,699	3,980,841	17,013,163
May	5,064,253	4,032,069	3,148,510	454,749	4,201,836	16,901,417
June	4,878,582	4,162,912	3,724,919	492,824	3,831,823	17,091,060
July	4,934,874	4,178,995	4,187,362	441,035	3,278,392	17,020,658
August	4,868,025	4,336,561	4,141,713	415,088	2,910,205	16,671,592
September	4,874,361	4,313,575	4,066,122	436,286	2,389,235	16,079,579
October	4,625,517	4,234,383	3,455,197	376,433	2,656,302	15,347,832
November	[a] 4,480,124	4,191,373	2,996,608	397,056	2,916,672	14,981,833
December	4,542,112	4,249,750	3,240,387	339,310	2,623,983	14,995,542

[a] Includes a small quantity of Illinois oil held by Tidewater pipe line.

WELL RECORD.

The following table gives the well record for the United States for 1910, by fields:

Well record in the United States in 1910, by fields.

Field.	Wells completed.				Initial daily production, in barrels.	
	Oil.	Gas.	Dry.	Total.	Total.	Average per well.
Appalachian	3,834	881	1,103	5,818	51,822	13.5
Pennsylvania and New York	1,673	243	285	2,201	6,683	4.0
Southeastern Ohio	947	76	466	1,489	18,038	19.1
Central Ohio [a]	6	126	18	150	78	13.0
West Virginia	1,138	436	283	1,857	26,194	23.0
Kentucky	70	....	51	121	829	11.8
Lima, Indiana	785	29	124	938	15,409	19.6
Lima, Ohio	501	13	58	572	6,745	13.5
Indiana	284	16	66	366	8,664	30.5
Illinois	1,681	75	393	2,149	93,256	55.5
MidContinent	3,381	458	556	4,395	230,218	68.1
Kansas	85	261	82	428	1,897	22.3
Oklahoma	3,188	181	408	3,777	226,638	71.1
Northern Texas	108	16	66	190	1,683	15.6
Gulf	521	48	180	749	218,458	419.3
Coastal Texas	365	....	116	481	63,283	173.5
Louisiana	156	48	64	268	155,175	994.7
California	763	4	50	817	....	....
Colorado	6	....	1	7	....	....
Wyoming	47	5	15	67	....	....
Total	11,018	1,500	2,422	14,940	....	....

[a] Last four months of the year.

PETROLEUM OPERATORS' STATISTICS OF PRODUCTION IN 1909 AND 1910.

The quantity and value of the petroleum product of the United States have been compiled for many years from complete returns sent in by the pipe lines and other transportation agencies, supplemented by returns from refineries and other consumers who occasionally obtain oil directly from wells. In some States—as Wyoming, California, and Utah—pipe-line facilities being lacking or incomplete, the production has always been obtained from the individual producers. The result of the compilation of these returns is given in the preceding report, which may be regarded as corresponding to the reports based on smelter returns for some of the metals.

Within the last few years persistent effort has been made by the United States Geological Survey to obtain complete statistics from producers in all the States as a check on pipe-line statistics and in order to furnish a more accurate means of subdividing the production by States and counties. The result of the compilation of these returns is given in the following pages and may be regarded as correspondin to the reports based on mine returns for some of the metals reported in Part I of Mineral Resources.

For the year 1909 the statistics of the production of petroleum were collected from producers under a cooperative agreement with the Bureau of the Census, by which the petroleum schedule of the United States Geological Survey was presented to all the producers by the agents of the census. As a result, practically complete replies were obtained from producers for the entire United States. In addition to statistics of the quantity produced and its value, the schedules contained much other important information, such as the acreage held by operators in each county under lease and in fee and the total number of wells in each county and their depth. These statistics obviously could not have been obtained in any way except by replies from the producers themselves. A like canvass was made by the Survey for the year 1910.

Production and value.—In compiling statements of production the effort has always been made to include only oil which was marketed and to omit oil which, though taken from the ground, remained in producers' storage at the wells.

The schedules of inquiry, therefore, called for the quantity of oil shipped, divided into the quantity retained by the operator and the quantity assigned as royalty to the landowner; also the stock on hand at the beginning and at the end of the year. The actual production, therefore, would consist of the quantity delivered to pipe lines less the stock at the beginning of the year and plus the stock at the end of the year; but in scrutinizing the returns it was found that the difference in production obtained by taking account of the change in stock at the wells was below the limits of error, and hence the production was taken simply as the total quantity delivered to pipe lines or other agencies during the year.

The result for 1909 showed a total of 177,150,521 barrels, valued at $120,178,113 at the wells, as compared with 183,170,874 barrels, valued at $128,328,487, the reported production obtained independently by correspondence with the transportation companies. The corresponding figures for 1910 are, according to the transportation method, 209,556,048 barrels, valued at $127,896,328, and according to the actual returns from producers, 198,026,646 barrels, valued at $118,955,429.

The two investigations of production for 1909 agreed in results within 3.5 per cent, a remarkably close agreement between two entirely different lines of inquiry. For various reasons the agreement in 1910 was not so close, especially in Texas and Oklahoma. It is manifestly impossible to say which total is the more accurate, since in 1909 of the total of 183,170,874 barrels only about 165,000,000 barrels were actually sent through pipe lines, the remainder representing railroad shipments, deliveries direct to refineries, etc. How much of the last item is duplicated in the pipe-line runs it is impossible to ascertain, though every care was taken to eliminate duplications. On the other hand, the returns from producers will necessarily fall slightly short of completeness. Probably the most serious difference is due to the assignment of production near the beginning or the close of the year, which is variously credited by producers to the preceding or the following year, whereas the pipe lines include it in the year under consideration. Of course in a series of years this difference will vanish.

The total value and the prices per barrel received by the producers were actual net values, and therefore less than the pipe-line prices because of penalties for water, etc.

Wells.—The returns received as to the number of wells drilled during the year are absolutely at variance with those reported by the sources which have been accepted as authoritative and which will continue to be taken as authoritative until the figures obtained from the producers are proved to be more accurate, it being certain that the returns here published are in specific cases too low. The total number of productive wells reported by producers as drilled in 1909 was 11,060, against 18,327 previously published. No satisfactory reason can be offered for this great difference, although inattention on the part of operators in answering this question may be a partial cause.

In 1909 this office published [1] an estimate of the total number of producing wells in the United States. This estimate was based on an assumed average length of life in each State. It aggregated 80,670 wells for the United States. The returns received from operators aggregate 148,440 wells at the close of 1910, showing that the former estimate was very much too low.

Average yield per well per day.—Among other features which are recorded here for the first time is the average yield of oil by all kinds of wells, both old and new, per well per day in each State, the average for the United States being 3.3 barrels in 1909 and 3.7 barrels in 1910.

Acreage.—Prior to 1909 no compilation had been made of the number of acres which are owned in fee and for which the oil rights are leased in each county in each State.

The following tables show the results of statistics obtained from producers as contrasted with the statistics given by transportation companies shown on previous pages. For 1909 the production is given by counties, but this has proved impracticable for 1910, although county field reports are given for the entire country.

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[1] Bull. U. S. Geol. Survey No. 394, 1909, p. 43.

Production and value of petroleum, well records, and acreage for the United States in 1909 and 1910, by States, from statistics furnished by producers.

1909.

State.	Production (in barrels). Placed to credit of— Producer.	Production (in barrels). Placed to credit of— Land-owner.	Production (in barrels). Total.	Value.	Average price per barrel.	Stock at wells (in barrels). Jan. 1.	Stock at wells (in barrels). Dec. 31.	Wells. Productive Jan. 1.	Wells. Completed in 1909. Oil.	Wells. Completed in 1909. Dry.	Wells. Abandoned.	Wells. Productive Dec. 31.	Average daily production per well.	Depth (feet).	Acreage.
California	a 48,537,651	a 6,933,950	55,471,601	$30,756,713	$0.554	2,054,845	1,988,952	3,816	702	70	71	4,447	34.1	....	586,036
Colorado	a 272,003	a 38,858	310,861	318,162	1.023	....	....	77	31	39	....	108	7.9	....	a 75,000
Illinois	26,020,364	4,122,713	30,143,077	18,963,752	.629	1,065,241	756,661	9,240	2,086	396	174	11,152	7.4	220–1,866	389,795
Indiana	1,745,393	257,542	2,002,935	1,694,941	.846	56,172	55,974	9,702	137	30	1,783	8,056	.7	300–2,000	190,363
Kansas	1,047,498	125,930	1,173,428	458,287	.391	13,238	17,416	1,927	42	10	138	1,831	1.7	300–1,800	120,333
Kentucky	462,101	59,761	521,862	401,127	.769	5,874	9,187	964	71	52	34	1,001	1.4	175–1,500	158,738
Louisiana	2,298,879	666,507	2,965,386	2,027,545	.684	67,002	69,084	160	77	29	39	198	41.0	980–2,400	319,029
Michigan, Missouri	a 5,031	a 719	5,750	7,830	1.362	....	....	3	....	3	....	3	5.0	....	a 1,000
New York	1,115,288	95,100	1,210,388	1,974,468	1.631	12,617	12,157	10,589	420	8	78	10,931	.3	350–2,250	124,432
Ohio	8,074,427	1,224,897	9,299,324	11,235,136	1.209	130,648	141,154	31,885	1,396	444	1,423	31,858	.8	90–3,200	664,944
Oklahoma	39,802,483	6,010,862	45,813,345	16,220,010	.355	4,743,603	5,608,381	9,830	2,202	173	145	11,887	10.6	300–2,325	1,595,466
Pennsylvania	7,867,726	837,663	8,705,389	14,186,873	1.630	129,493	111,022	49,043	2,333	188	1,066	50,310	.8	200–3,300	1,492,793
Texas	8,191,645	1,195,915	9,387,560	6,675,991	.711	68,643	58,122	2,108	521	208	252	2,377	10.8	81–2,400	226,866
Utah, Wyoming	a 17,549	a 2,507	20,056	34,456	1.718	....	....	70	54	43	....	124	.4	....	a 205,000
West Virginia	8,798,399	1,321,160	10,119,559	15,222,822	1.505	162,784	186,331	12,485	988	188	638	12,835	2.2	215–3,580	2,124,830
Total	151,256,437	22,894,084	177,150,521	120,178,113	.678	8,510,160	9,014,441	141,899	11,060	1,881	5,841	147,118	3.3	81–3,300	8,274,625

a Estimated.

Production and value of petroleum, well records, and acreage for the United States in 1909 and 1910, by States, etc.—Continued.

1910.

State.	Production (in barrels). Placed to credit of— Producer.	Production (in barrels). Placed to credit of— Land-owner.	Production (in barrels). Total.	Value.	Average price per barrel.	Stock at wells (in barrels). Jan. 1.	Stock at wells (in barrels). Dec. 31.	Wells. Productive Jan. 1.	Wells. Completed in 1910. Oil.	Wells. Completed in 1910. Dry.	Wells. Abandoned.	Wells. Productive Dec. 31.	Wells. Drilling Dec. 31.	Average daily production per well.	Acreage. Fee.	Acreage. Lease.	Acreage. Total.
California	a 63,884,240	a 9,126,320	73,010,560	$35,749,473	$0.490	1,988,952	4,156,450	4,447	763	50	83	5,127	661	39.0	b 232,506	384,185	616,691
Colorado	a 209,820	a 29,974	239,794	243,402	1.015	....	....	108	6	1	2	112	8	5.9	11,575	67,192	78,767
Illinois	27,740,228	4,381,412	32,121,640	18,911,045	.589	756,661	548,884	11,152	1,404	214	385	12,171	50	7.2	3,384	405,195	408,579
Indiana	1,436,829	212,731	1,649,560	1,200,660	.728	55,974	46,268	8,056	134	16	1,739	6,451	11	.7	3,494	123,451	126,945
Kansas	963,108	111,994	1,075,102	432,638	.402	17,416	17,949	1,831	53	26	97	1,787	4	1.6	9,651	101,589	111,240
Kentucky	397,199	49,592	446,791	320,009	.716	9,187	5,415	1,001	49	52	62	988	8	1.2	3,678	132,435	136,113
Louisiana	5,978,362	1,072,153	7,050,575	3,686,132	.523	69,084	52,998	198	130	48	40	288	27	67.1	11,991	970,042	982,033
Michigan, Missouri	a 3,163	a 452	3,615	4,794	1.326	....	....	3	2	6	....	5	......	2.0	....	a 1,000	a 1,000
New York	988,567	87,418	1,075,985	1,432,592	1.331	12,157	13,511	10,931	135	4	71	10,995	2	.3	38,690	70,253	108,943
Ohio	7,255,759	1,109,398	8,365,157	8,727,860	1.043	141,154	132,137	31,858	770	197	1,782	30,846	66	.7	29,659	655,327	684,986
Oklahoma	41,862,570	5,658,614	47,521,184	18,408,419	.387	5,608,381	6,449,286	11,887	2,194	203	325	13,756	91	9.5	23,056	1,282,825	1,305,881
Pennsylvania	7,043,295	764,732	7,808,027	10,543,810	1.354	111,022	103,438	50,310	847	104	869	50,288	27	.4	229,388	797,546	1,026,934
Texas	6,014,078	528,336	6,542,414	4,740,781	.725	58,122	94,137	2,377	312	128	182	2,507	16	7.1	56,188	703,254	759,442
Utah, Wyoming	a 101,001	a 14,429	115,430	93,536	.810	....	....	17	......	......	....	17	16	1.9	c 9,910	520	10,430
								107	47	15	5	149	18		d 25,260	176,430	201,690
West Virginia	9,666,839	1,334,033	11,000,872	14,460,278	1.314	186,331	158,354	12,835	690	140	572	12,953	144	2.3	31,706	2,689,188	2,720,894
Total	173,545,058	24,481,588	198,026,646	118,955,429	.601	9,014,441	11,778,827	147,118	7,536	1,204	6,214	148,440	1,129	3.7	720,136	8,560,432	9,280,568

a Estimated. b Includes 70,194 acres of oil locations. c Includes 200 acres of oil locations. d Includes 15,240 acres of oil locations.

Total production of petroleum in 1909 and 1910, by States, and percentage of increase or decrease in 1910 as compared with 1909, in barrels.

State.	Production.		Increase.	Decrease.	Percentage.	
	1909	1910			Increase.	Decrease.
California	55,471,601	73,010,560	17,558,959		31.62	
Colorado	310,861	239,794		71,067		22.86
Illinois	30,143,077	32,121,640	1,978,563		6.56	
Indiana	2,002,935	1,649,560		353,375		17.64
Kansas	1,173,428	1,075,102		98,326		8.38
Kentucky	521,862	446,791		75,071		14.39
Louisiana	2,965,386	7,050,515	4,085,129		137.76	
Michigan, Missouri	5,750	3,615		2,135		37.13
New York	1,210,388	1,075,985		134,403		11.10
Ohio	9,299,324	8,365,157		934,167		10.05
Oklahoma	45,813,345	47,521,184	1,707,839		3.73	
Pennsylvania	8,705,389	7,808,027		897,362		10.31
Texas	9,387,560	6,542,414		2,845,146		30.31
Utah, Wyoming	20,056	115,430	95,374		475.54	
West Virginia	10,119,559	11,000,872	881,313		8.71	
Total	177,150,521	198,026,646	20,876,125		11.78	

The following tables give the detailed statistics of production of petroleum, by counties, in the respective States in 1909:

Statistics of production of petroleum in 1909, by counties.

County	Production (in barrels).			Value.	Average price per barrel.	Stock at wells (in barrels).		Wells.						Acreage.
	Placed to credit of—		Total.			Jan. 1.	Dec. 31.	Productive Jan. 1.	Completed in 1909.		Abandoned.	Productive Dec. 31.	Depth (feet).	
	Producer.	Landowner.							Oil.	Dry.				
NEW YORK.														
Allegany	743,196	58,620	801,816	$1,301,959	$1.624	4,948	4,460	7,516	338	8	52	7,802	409–2,000	72,168
Cattaraugus	341,663	32,673	374,336	616,929	1.648	6,836	6,820	2,859	78	....	26	2,911	350–2,250	47,733
Steuben	30,429	3,807	34,236	55,580	1.623	833	877	214	4	....	....	218	600–1,500	4,531
Total	1,115,288	95,100	1,210,388	1,974,468	1.631	12,617	12,157	10,589	420	8	78	10,931	350–2,250	124,432
PENNSYLVANIA.														
Allegheny	681,784	88,480	770,264	$1,248,369	$1.621	16,270	20,904	1,703	53	20	28	1,728	1,000–2,588	198,560
Armstrong	47,061	4,943	52,004	86,857	1.670	172	153	168	9	5	6	171	620–1,800	4,449
Beaver	112,063	13,026	125,089	200,891	1.606	2,052	2,096	646	24	1	41	629	490–1,900	25,567
Butler	1,510,630	186,392	1,697,022	2,739,434	1.614	18,741	22,071	5,349	246	40	102	5,493	750–2,567	93,690
Clarion	360,307	35,266	395,573	641,742	1.621	2,272	2,550	1,520	97	21	19	1,598	512–1,350	52,565
Crawford	51,757	6,947	58,704	91,997	1.567	386	496	451	56	....	7	500	450– 950	4,104
Elk	186,158	21,257	207,415	341,353	1.646	6,607	6,937	1,030	36	1	3	1,063	1,700–2,630	90,322
Forest	203,530	22,044	225,574	365,179	1.619	3,293	3,127	1,522	62	9	72	1,512	200–1,950	78,293
Greene	263,030	34,030	297,060	474,930	1.598	8,534	8,833	425	26	9	18	433	700–3,200	160,304
Jefferson	52,331	4,983	57,314	93,958	1.639	2,033	2,003	112	14	1	1	125	1,875–2,500	44,406
Lawrence	6,993	315	7,308	11,635	1.592	....	300	9	....	1	....	9	650– 750	2,570
McKean	1,541,921	136,437	1,678,358	2,775,912	1.654	31,288	3,738	14,282	424	18	135	14,571	625–2,593	203,521
Mercer	90,625	12,248	102,873	137,408	1.336	40	30	202	65	3	....	267	500–1,600	3,578
Potter	32,503	3,785	36,288	58,709	1.618	....	....	132	28	....	1	159	1,030–2,200	56,841
Tioga	5,232	957	6,189	8,777	1.418	57	59	45	....	....	....	45	700–1,050	685
Venango	1,525,951	131,609	1,657,560	2,742,165	1.654	8,428	9,239	13,160	952	46	235	13,877	280–1,500	211,874
Warren	524,295	48,101	572,396	926,544	1.619	8,953	8,852	6,477	181	10	350	6,308	214–2,165	88,340
Washington	671,555	86,843	758,398	1,240,913	1.636	20,367	19,634	1,810	60	3	48	1,822	1,600–3,300	173,124
Total	7,867,726	837,663	8,705,389	14,186,773	1.630	129,493	111,022	49,043	2,333	188	1,066	50,310	200–3,300	1,492,793

WEST VIRGINIA.

Brooke	400,719	25,595	426,314	$558,334	$1.310	979	1,344	318	48	8	6	360	1,100-2,250	6,945
Cabell [a]	28,605	3,800	32,405	38,820	1.198	17	19	28	5		3	30	1,400-1,650	13,821
Calhoun	85,209	12,069	97,278	157,561	1.620	2,214	2,653	279	4	5	16	267	1,400-2,500	42,289
Doddridge	344,078	48,479	392,557	545,177	1.389	9,789	10,792	567	11	1	2	576	1,500-3,267	74,148
Gilmer	62,414	8,753	71,167	116,030	1.630	1,318	1,488	84	3			87	2,300-2,400	61,807
Hancock	79,953	9,033	88,986	129,068	1.450	63	61	336	2		20	318	600-1,500	8,018
Harrison	1,439,303	203,408	1,642,711	2,606,791	1.587	35,787	46,009	957	137	15	5	1,089	1,850-3,300	136,542
Lewis	150,468	21,538	172,006	275,779	1.603	4,870	4,673	208	28		4	232	2,200-3,000	98,588
Lincoln	1,272,918	174,813	1,447,731	2,305,280	1.592			148	180	1		328	1,140-2,500	271,809
Marion	442,285	63,229	505,514	810,510	1.605	12,611	15,206	665	23	1	5	683	1,918-3,563	98,726
Marshall	110,523	15,828	126,351	204,058	1.615	2,359	2,857	234	9	1	35	208	1,500-3,000	89,425
Monongalia	604,380	85,905	690,285	1,116,875	1.618	16,452	19,134	744	29	1	1	772	1,888-3,325	67,470
Pleasants	317,423	158,360	475,783	750,896	1.578	6,141	6,639	1,570	138	43	74	1,634	312-2,300	32,098
Ritchie	856,387	122,668	979,055	1,575,944	1.610	18,307	19,280	1,851	129	22	137	1,843	225-2,600	80,849
Roane	772,868	111,186	884,054	1,416,217	1.602	12,590	16,717	314	104	13		418	1,127-2,420	121,309
Tyler	686,299	97,656	783,955	547,817	.699	6,607	21,576	1,722	55	29	117	1,660	1,100-3,580	91,324
Wetzel	842,239	119,576	961,815	1,530,711	1.591	28,269	12,910	1,403	37	5	195	1,245	1,800-3,400	134,719
Wirt	109,148	12,235	121,383	186,121	1.533	882	981	343	22	13	18	347	215- 278	24,457
Wood	193,180	27,029	220,209	350,833	1.593	3,529	3,992	714	24	30		738	380-2,300	11,041
Miscellaneous (undeveloped)														659,445
Total	8,798,399	1,321,160	10,119,559	15,222,822	1.505	162,784	186,331	12,485	988	188	638	12,835	215-3,580	2,124,830

KENTUCKY.

Barren								9				9	175- 225	566
Bath								91				91	332-1,000	33,336
Cumberland								4	2	8	6		1,000-1,313	156
Floyd	46,500	6,280	52,780	$37,842	$0.717	2,371	4,251	18				18	332-1,300	3,260
Knott								1				1	1,400	1,546
Logan								4	3	11	2	5	800-1,000	6,000
Rowan								37			2	35	330- 365	700
Wayne	338,085	42,403	380,488	294,937	.776	2,787	3,871	645	66	33	15	696	250-1,167	62,208
Wolfe	77,516	11,078	88,594	68,348	.771	626	1,065	155			9	146	1,000-1,500	3,000
Miscellaneous (undeveloped)														47,966
Total	462,101	59,761	521,862	401,127	.769	5,784	9,187	964	71	52	34	1,001	175-1,500	158,738

[a] Includes Putnam.

Statistics of production of petroleum in 1909, by counties—Continued.

OHIO.

County.	Production (in barrels). Placed to credit of— Producer.	Production (in barrels). Placed to credit of— Land-owner.	Production (in barrels). Total.	Value.	Average price per barrel.	Stock at wells (in barrels). Jan. 1.	Stock at wells (in barrels). Dec. 31.	Wells. Productive Jan. 1.	Wells. Completed in 1909. Oil.	Wells. Completed in 1909. Dry.	Wells. Abandoned.	Wells. Productive Dec. 31.	Wells. Depth (feet).	Acreage.
Allen	285,973	48,987	334,960	$305,534	$0.912	3,976	3,679	2,300	7	9	148	2,159	1,100-1,450	31,931
Athens	16,471	2,352	18,823	25,513	1.356	1,981	1,997	155	9	10	44	120	400-1,400	11,468
Auglaize	125,016	18,098	143,114	140,438	.981	2,797	2,905	667	5	2	59	613	1,100-1,400	20,699
Belmont [a]	58,368	8,251	66,619	107,654	1.615	120	442	229	21	3	42	208	1,200-1,500	5,234
Carroll	4,382	681	5,063	8,081	1.596	....	....	16	7	4	1	22	963-1,464	5,675
Columbiana [b]	148,508	20,982	169,490	254,772	1.503	66	79	241	61	16	3	299	600-1,400	11,460
Fairfield	387,230	54,108	441,338	653,767	1.481	5,938	8,613	41	81	8	9	113	2,200-3,200	21,321
Hancock	933,558	155,976	1,089,534	1,060,379	.973	15,339	14,586	3,898	37	16	116	3,819	1,025-1,800	36,476
Harrison	124,854	16,855	141,709	216,187	1.526	2,301	2,002	831	48	8	42	837	900-2,200	14,330
Holmes [c]	6,249	871	7,120	5,962	.837	151	152	26	14	1	1	39	650-1,250	3,573
Jefferson	402,730	66,356	469,086	760,351	1.621	3,462	1,946	282	110	28	47	345	1,000-1,800	37,698
Knox [d]	12,565	1,793	14,358	15,148	1.055	230	....	11	2	....	3	10	1,600-3,000	38,698
Lucas	122,842	21,511	144,353	135,259	.937	3,105	2,786	624	12	1	35	601	1,175-1,600	16,710
Mercer	112,058	18,344	130,402	121,641	.933	2,471	2,188	937	1	....	31	907	1,100-1,400	18,664
Monroe	1,194,352	165,251	1,359,603	2,065,805	1.513	22,218	28,363	2,429	194	77	80	2,543	550-3,200	77,524
Morgan	62,704	8,500	71,204	110,296	1.549	270	774	679	38	23	45	672	90-1,400	10,098
Muskingum	72,305	10,359	82,664	85,265	1.031	471	230	131	27	3	....	158	900-1,500	5,117
Noble	98,980	12,984	111,964	174,006	1.554	544	504	309	74	57	7	376	200-2,000	10,819
Ottawa	89,406	16,522	105,928	100,228	.946	1,333	1,288	494	25	1	55	464	1,250-1,500	6,816
Perry	168,575	26,554	195,129	308,001	1.578	4,604	5,674	112	61	16	1	172	1,050-3,200	32,198
Sandusky	572,762	90,295	663,057	610,102	.920	7,299	7,978	4,603	46	6	109	4,540	1,000-1,795	53,868
Seneca	146,075	26,198	172,273	156,115	.906	1,892	1,717	657	48	11	70	635	1,150-1,800	19,163
Shelby	6,436	1,267	7,703	7,181	.932	71	73	32	....	....	....	32	1,200-1,325	610
Trumbull [e]	337	30	367	2,325	6.335	....	168	15	2	2	2	15	....	427
Van Wert	133,855	21,678	155,533	136,210	.876	1,054	1,084	845	38	11	70	813	1,000-1,600	16,122
Vinton [f]	9,669	1,382	11,051	14,257	1.418	722	559	26	....	....	....	26	1,200-1,250	2,833
Washington	937,976	127,633	1,065,609	1,586,828	1.490	10,602	12,163	3,018	292	105	91	3,219	190-2,100	69,806
Wood	1,806,908	276,233	2,083,141	2,029,430	.974	36,861	38,427	8,084	136	25	291	7,929	1,000-1,654	80,697
Wyandot	33,283	4,846	38,129	38,401	1.007	770	797	193	....	1	21	172	1,200-1,500	4,909
Total	8,074,427	1,224,897	9,299,324	11,235,136	1.209	130,648	141,154	31,885	1,396	444	1,423	31,858	90-3,200	664,944

INDIANA.														
Adams	181,572	25,927	207,499	$174,564	$0.841	1,794	1,836	1,149	2	3	131	1,020	800–1,300	14,128
Blackford	84,411	12,732	97,143	85,014	.875	2,619	2,287	682	3	2	236	449	950–1,500	12,066
Delaware	154,678	25,062	179,740	153,402	.853	4,249	5,579	312	1	2	75	238	300–1,350	11,459
Gibson	63,291	9,043	72,334	58,582	.810	2,052	1,820	192	4	2	34	162	850–1,000	11,211
Grant	386,368	55,792	442,160	382,935	.866	17,812	15,210	2,497	30	1	347	2,180	950–1,600	26,970
Huntington	139,457	21,026	160,483	140,219	.874	6,357	5,135	872	4	2	189	687	1,000–1,500	7,374
Jay	204,325	32,775	237,100	200,877	.847	1,719	1,787	1,080	17	12	229	868	900–2,000	20,380
Pike	69,467	9,260	78,727	50,343	.639	177	5,935	3	32	4	....	35	1,100–1,239	29,897
Randolph	47,340	6,225	53,565	45,235	.844	421	394	115	10	1	80	45	1,000–1,400	3,073
Vigo g	15,892	1,595	17,487	10,878	.623	3,097	3,012	11	1	....	....	12	h 765–1,638	909
Wells	398,592	58,105	456,697	392,892	.860	15,875	12,979	2,779	33	1	462	2,350	1,000–1,350	33,908
Miscellaneous and undeveloped	....	....	....	....	....	....	....	10	....	....	....	10	....	18,988
Total	1,745,393	257,542	2,002,935	1,694,941	.846	56,172	55,974	9,702	137	30	1,783	8,056	300–2,000	190,363
ILLINOIS.														
Clark	2,804,057	433,579	3,237,636	$2,039,730	$0.630	81,142	70,351	2,288	172	56	44	2,416	i 280–1,000	49,036
Coles	25,387	3,923	29,310	17,790	.607	74	101	50	17	1	2	65	350–1,000	1,324
Crawford	11,042,402	1,751,106	12,793,508	7,997,294	.625	592,131	371,378	5,003	1,142	256	77	6,068	400–1,400	107,304
Cumberland	777,011	118,435	895,446	566,401	.633	15,745	20,891	645	44	41	40	649	220–1,400	4,869
Edgar	175	35	210	177	.843	80	60	10	....	....	3	7	265– 517	630
Lawrence	11,361,707	1,814,271	13,175,978	8,337,044	.633	376,069	293,720	1,238	707	40	8	1,937	880–1,866	85,200
Miscellaneous j	9,625	1,364	10,989	5,316	.484	....	160	6	4	2	....	10	1,500–1,850	141,432
Total	26,020,364	4,122,713	30,143,077	18,963,752	.629	1,065,241	756,661	9,240	2,086	396	174	11,152	220–1,866	389,795
KANSAS.														
Allen	79,477	6,419	85,896	$34,105	$0.397	1,700	900	158	2	1	4	156	700– 900	6,086
Chautauqua k	595,514	72,733	668,247	262,957	.394	3,885	4,099	784	25	7	24	785	585–1,800	29,969
Franklin	5,271	748	6,019	2,389	.397	....	....	46	....	....	21	25	350– 600	1,275
Miami	8,921	1,330	10,251	3,617	.353	....	....	38	....	....	4	34	300– 600	1,065
Montgomery	184,091	25,949	210,040	71,830	.342	1,826	7,528	448	3	....	1	450	400–1,300	57,008
Neosho l	110,702	10,525	121,227	56,610	.467	3,187	2,427	255	12	2	82	185	680–1,400	7,050
Wilson	63,522	8,226	71,748	26,779	.373	2,640	2,462	198	....	....	2	196	440–1,200	17,880
Total	1,047,498	125,930	1,173,428	458,287	.391	13,238	17,416	1,927	42	10	138	1,831	300–1,800	120,333

a Includes Guernsey County.
b Includes Mahoning County.
c Includes Coshocton and Tuscarawas Counties.
d Includes Richland County.
e Includes Lorain County.
f Includes Jackson County.
g Includes Sullivan County.
h Sullivan County, 765–768; Vigo County, 1,620–1,638.
i One productive well has been drilled to 2,200 feet.
j Includes Madison, Marion, Perry, and Randolph counties and undeveloped leases.
k Includes Elk and Coffey counties.
l Includes Labette County.

Statistics of production of petroleum in 1909, by counties—Continued.

OKLAHOMA.

County.	Production (in barrels). Placed to credit of— Producer.	Production (in barrels). Placed to credit of— Land-owner.	Production (in barrels). Total.	Value.	Average price per barrel.	Stock at wells (in barrels). Jan. 1.	Stock at wells (in barrels). Dec. 31.	Wells. Produc-tive Jan. 1.	Wells. Completed in 1909. Oil.	Wells. Completed in 1909. Dry.	Wells. Aban-doned.	Wells. Produc-tive Dec. 31.	Wells. Depth (feet).	Acreage.
Cherokee	56,404	10,910	67,314	$24,681	$0.367	646	82	30	3	....	1	32	395– 750	1,214
Creek	13,385,689	2,056,090	15,441,779	5,126,085	.332	2,122,097	1,823,334	1,220	383	10	8	1,595	700–1,776	41,878
Kiowa a	5,301	584	5,885	5,118	.870	....	80	8	3	....	3	8	380– 460	15,200
Muskogee b	1,189,669	212,779	1,402,448	526,501	.375	38,808	183,096	105	84	16	22	167	1,060–1,755	68,020
Nowata	8,108,803	1,108,301	9,217,104	3,406,933	.370	379,914	1,123,027	3,421	769	57	19	4,171	350– 900	82,459
Okmulgee	1,075,003	146,648	1,221,651	421,606	.345	50,973	40,275	94	45	8	5	134	1,200–2,325	29,816
Osage	3,143,984	657,669	3,801,653	1,433,602	.377	200,966	421,917	928	79	15	23	984	325– 650 1,050–2,000	1,172,211
Pawnee	544,884	70,641	615,525	224,017	.364	14,395	17,813	176	36	....	11	201	1,055–1,826	7,226
Rogers	1,564,137	190,395	1,754,532	662,279	.377	28,951	33,201	1,363	167	19	13	1,517	350– 900 1,130–1,250	23,581
Tulsa	5,338,982	666,737	6,005,719	2,058,319	.343	1,736,933	1,815,979	575	258	16	10	823	453– 694 998–1,732	24,199
Washington	5,389,627	890,108	6,279,735	2,330,869	.371	169,920	149,577	1,892	359	27	28	2,223	500–1,625	108,248
Miscellaneous c	....	....	....	....	....	....	....	18	16	5	2	32	300–2,323	21,414
Total	39,802,483	6,010,862	45,813,345	16,220,010	.355	4,743,603	5,608,381	9,830	2,202	173	145	11,887	300–2,325	1,595,466

LOUISIANA.

County.	Producer.	Land-owner.	Total.	Value.	Average price per barrel.	Jan. 1.	Dec. 31.	Produc-tive Jan. 1.	Oil.	Dry.	Aban-doned.	Produc-tive Dec. 31.	Depth (feet).	Acreage.
Acadia	1,539,446	561,249	2,100,695	$1,504,843	$0.716	17,309	24,430	104	17	6	23	98	1,500–2,400	1,100
Caddo	678,696	102,212	780,908	460,822	.590	9,708	12,030	46	54	11	13	87	1,000–2,375	61,123
Calcasieu	40,237	3,046	43,283	33,480	.774	38,985	32,624	7	4	1	2	9	980–1,900	604
St. Martin	40,500	....	40,500	28,400	.701	1,000	....	3	2	4	1	4	1,200–1,900	232
Miscellaneous d	....	....	....	....	....	....	....	....	....	7	....	....	....	255,970
Total	2,298,879	666,507	2,965,386	2,027,545	.684	67,002	69,084	160	77	29	39	198	980–2,400	319,029

TEXAS.

Clay	118,947	8,143	127,090	$65,031	$0.512	510	994	126	30	8	6	150	260– 750	62,477
Hardin	4,113,414	332,584	4,445,998	3,207,650	.721			748	177	63	132	793	310–1,850	4,583
Harris	2,421,223	655,992	3,077,215	2,214,467	.720	25,570	20,783	206	143	81	50	299	600–2,400	5,311
Jefferson and Liberty	867,439	133,037	1,000,476	736,876	.736			123	47	22	40	130	700–1,200	2,017
Matagorda [e]	136,144	4,133	140,277	103,608	.739	1,616	2,353	15	23	8	6	32	[f] 385–1,400	52,501
Navarro [g]	534,478	62,026	596,504	348,359	.584	40,947	33,992	890	101	22	18	973	[h] 81–1,650	40,601
Sabine, Shelby, and Walker										4				24,700
Miscellaneous (undeveloped)														34,676
Total	8,191,645	1,195,915	9,387,560	6,675,991	.711	68,643	58,122	2,108	521	208	252	2,377	81–2,400	226,866

[a] Includes Comanche County.
[b] Includes McIntosh, Marshall, and Wagoner counties.
[c] Includes Atoka, Carter, Craig, and Pittsburg counties and undeveloped leases.
[d] Includes St. Landry, St. Mary, and Terrebonne parishes and undeveloped leases.
[e] Includes Bexar, Brazoria, De Witt, Duval, and McMullen counties.
[f] Bexar County, 900–1,029 feet; Brazoria County, 500–1,000 feet; Duval County, 385–468 feet; McMullen County, 630–750 feet.
[g] Includes Anderson, Brown, Coleman, Dallas, and McLennan counties.
[h] Brown County, 81–152 feet; McLennan County, 485–510 feet; Navarro County, 700–1,650 feet.

The following tables give the field reports of the petroleum industry in 1910 for the respective States by counties:

Petroleum field report in 1910, by counties.

NEW YORK.

County.	Wells.						Acreage.		
	Productive Jan. 1.	Completed in 1910.		Abandoned.	Productive Dec. 31.	Drilling Dec. 31.	Fee.	Lease.	Total.
		Oil.	Dry.						
Allegany	7,802	118	4	61	7,859	2	24,337	48,861	73,198
Cattaraugus	2,911	16	...	10	2,917	...	12,753	20,005	32,758
Steuben	218	1	...	...	219	...	1,600	1,387	2,987
Total	10,931	135	4	71	10,995	2	38,690	70,253	108,943

PENNSYLVANIA.

County.	Productive Jan. 1.	Oil.	Dry.	Abandoned.	Productive Dec. 31.	Drilling Dec. 31.	Fee.	Lease.	Total.
Allegheny	1,728	69	10	54	1,743	5	4,689	37,206	41,895
Armstrong	171	9	3	2	178	3	547	2,828	3,375
Beaver	629	4	3	20	613	...	2,219	23,109	25,328
Butler	5,493	74	22	216	5,351	6	26,222	79,892	106,114
Clarion	1,598	44	10	47	1,595	1	10,410	49,088	59,498
Crawford	500	10	...	3	507	...	287	3,610	3,897
Elk	1,063	15	...	...	1,078	1	15,632	87,720	103,352
Fayette	...	...	...	...	...	...	...	1,766	1,766
Forest	1,512	22	6	33	1,501	1	27,873	37,189	65,062
Greene	433	18	12	23	428	5	615	69,041	69,656
Jefferson	125	1	...	...	126	1	5,782	39,679	45,461
Lawrence	9	13	2	...	22	...	...	2,200	2,200
McKean	14,571	142	5	104	14,609	3	66,976	111,151	178,127
Mercer	267	4	...	...	271	...	550	2,581	3,131
Potter	159	...	...	...	159	...	304	15,011	15,315
Tioga	45	...	...	4	41	...	...	635	635
Venango	13,877	338	14	226	13,989	1	45,170	87,866	133,036
Warren	6,308	71	15	67	6,312	...	20,803	44,133	64,936
Washington	1,822	13	2	70	1,765	...	1,309	102,841	104,150
Total	50,310	847	104	869	50,288	27	229,388	797,546	1,026,934

WEST VIRGINIA.

County.	Productive Jan. 1.	Oil.	Dry.	Abandoned.	Productive Dec. 31.	Drilling Dec. 31.	Fee.	Lease.	Total.
Brooke	360	3	4	8	355	...	820	8,487	9,307
Cabell	29	2	...	5	26	...	...	48,926	48,926
Calhoun	267	4	...	6	265	1	131	53,608	53,739
Doddridge	576	24	14	13	587	16	926	100,904	101,830
Gilmer	87	9	2	12	84	1	1,080	57,994	59,074
Hancock	318	10	2	8	320	...	663	8,909	9,572
Harrison	1,089	70	24	16	1,143	15	3,410	100,865	104,275
Lewis	232	14	...	15	231	...	50	139,279	139,329
Lincoln	328	121	1	11	438	5	12	226,022	226,034
Marion	683	37	2	48	672	7	1,853	70,796	72,649
Marshall	208	7	...	18	197	...	...	85,114	85,114
Monongalia	772	13	2	27	758	4	1,178	80,151	81,329
Ohio	...	...	1	...	...	...	...	5,086	5,086
Pleasants	1,634	40	14	66	1,608	2	623	25,152	25,775
Putnam	1	...	1	1	...	...	...	85,990	85,990
Ritchie	1,843	80	22	54	1,869	12	2,695	115,545	118,240
Roane	418	132	11	2	548	64	11,954	476,090	488,044
Tyler	1,660	67	18	117	1,610	6	56	62,119	62,175
Wayne	...	2	1	...	2	1	...	60,252	60,252
Wetzel	1,245	13	...	83	1,175	7	451	91,481	91,932
Wirt	347	9	6	20	336	2	4,731	18,972	23,703
Wood	738	33	15	42	729	1	1,073	13,198	14,271
Miscellaneous (undeveloped)	...	...	...	...	...	...	...	754.248	754,248
Total	12,835	690	140	572	12,953	144	31,706	2,689,188	2,720,894

Petroleum field report in 1910, by counties—Continued.

KENTUCKY.

County.	Wells.						Acreage.		
	Productive Jan. 1.	Completed in 1910.		Abandoned.	Productive Dec. 31.	Drilling Dec. 31.	Fee.	Lease.	Total.
		Oil.	Dry.						
Barren	9				9		31	514	545
Bath	91				91		5	32,513	32,518
Floyd	18				18		85	2,825	2,910
Knott	1				1			1,851	1,851
Lawrence		3	2	3				32,167	32,167
Logan	5	2	2		7	2	2,000	871	2,871
Rowan	35				35			600	600
Wayne	696	44	48	55	685	6	1,557	56,724	58,281
Wolfe	146			4	142			2,070	2,070
Miscellaneous (undeveloped)								2,300	2,300
Total	1,001	49	52	62	988	8	3,678	132,435	136,113

OHIO.

County.	Productive Jan. 1.	Oil.	Dry.	Abandoned.	Productive Dec. 31.	Drilling Dec. 31.	Fee.	Lease.	Total.
Allen	2,159	16		245	1,930		246	15,099	15,345
Athens	120	1			121		1,183	11,000	12,183
Auglaize	613	28	1	37	604	2	1,079	18,736	19,815
Belmont	199	2	2	16	185	3		17,263	17,263
Carroll	22	25	14	2	45	3		6,260	6,260
Columbiana	299	12	12	2	309		1,595	18,846	20,441
Coshocton	12	1	2		13			15,248	15,248
Fairfield	113	68	9	4	177	11	1	22,838	22,839
Guernsey	9	1	4		10			493	493
Hancock	3,819	43		196	3,666	1	1,826	38,121	39,947
Harrison	837	20	8	68	789		1,499	12,823	14,322
Hocking		2			2	1		12,044	12,044
Holmes	23	3		3	23			2,693	2,693
Jackson	12	5			17			160	160
Jefferson	345	17	29	51	311	5	680	25,115	25,795
Knox	10	1		3	8			40,205	40,205
Logan						1		9,000	9,000
Lorain	9				9			70	70
Lucas	601	8	3	30	579	1	617	11,353	11,970
Medina		3			3				
Mercer	907			76	831		1,843	15,656	17,499
Monroe	2,543	55	23	95	2,503	1	1,006	54,662	55,668
Morgan	672	12	12	75	609		190	8,188	8,378
Muskingum	158	1	2	2	157		160	9,000	9,160
Noble	376	24	6	22	378		820	11,712	12,532
Ottawa	464	10	3	68	406		80	8,555	8,635
Perry	172	56	19	9	219	23	73	44,865	44,938
Ross		1		1					
Sandusky	4,540	39	4	112	4,467	1	5,174	42,945	48,119
Seneca	635	8	2	20	623		579	17,350	17,929
Shelby	32			6	26			670	670
Trumbull	6		3	2	4		56	70	126
Tuscarawas	4			1	3			239	239
Van Wert	813	27		71	769	2	120	12,926	13,046
Vinton	14	5	2	3	16	1	1,187	1,286	2,473
Washington	3,219	213	17	97	3,335	10	2,005	43,155	45,160
Wood	7,929	63	20	430	7,562		6,746	74,970	81,716
Wyandot	172			35	137		894	3,559	4,453
Miscellaneous (undeveloped)								28,152	28,152
Total	31,858	770	197	1,782	30,846	66	29,659	655,327	684,986

Petroleum field report in 1910, by counties—Continued.

INDIANA.

County.	Wells.						Acreage.		
	Productive Jan. 1.	Completed in 1910.		Abandoned.	Productive Dec. 31.	Drilling Dec. 31.	Fee.	Lease.	Total.
		Oil.	Dry.						
Adams	1,020	16		133	903	10	879	12,034	12,913
Blackford	449			120	329		500	7,162	7,662
Delaware	238			40	198			10,804	10,804
Gibson	162			10	152		240	7,043	7,283
Grant	2,180			719	1,461		411	19,829	20,240
Huntington	687			115	572		216	7,394	7,610
Jay	868	45	8	50	863		40	7,668	7,708
Pike	35	65	5	4	96		40	14,828	14,868
Randolph	45	5	2	7	43			2,657	2,657
Sullivan	4	2			6			220	220
Vigo	8				8			590	590
Wells	2,350			541	1,809		1,168	29,743	30,911
Miscellaneous [a]	10	1	1		11	1		3,479	3,479
Total	8,056	134	16	1,739	6,451	11	3,494	123,451	126,945

ILLINOIS.

County.	Productive Jan. 1.	Oil.	Dry.	Abandoned.	Productive Dec. 31.	Drilling Dec. 31.	Fee.	Lease.	Total.
Clark	2,416	49	12	124	2,341		1,065	58,515	59,580
Coles	65	3		1	67		140	575	715
Crawford	6,068	801	113	217	6,652	15	913	102,737	103,650
Cumberland	649	32	5	4	677			6,221	6,221
Edgar	7			1	6		530	80	610
Jersey			4						
Lawrence	1,937	512	72	38	2,411	30	329	80,615	80,944
Macoupin						1		23,793	23,793
Madison			4					11,486	11,486
Marion	5	7	4		12	4		35,920	35,920
Randolph	5				5		407	493	900
Miscellaneous (undeveloped)								84,760	84,760
Total	11,152	1,404	214	385	12,171	50	3,384	405,195	408,579

KANSAS.

County.	Productive Jan. 1.	Oil.	Dry.	Abandoned.	Productive Dec. 31.	Drilling Dec. 31.	Fee.	Lease.	Total.
Allen	156	9	18	5	160	2	1,017	7,529	8,546
Chautauqua [b]	785	34	3	45	774	2	4,125	30,447	34,572
Franklin	25				25			327	327
Miami	34			1	33		3	371	374
Montgomery	450	8		27	431		324	30,015	30,339
Neosho [c]	185	2	5	16	171		610	12,502	13,112
Wilson	196			3	193		3,572	20,398	23,970
Total	1,831	53	26	97	1,787	4	9,651	101,589	111,240

[a] Includes Greene, Hamilton, and Perry counties and undeveloped leases.
[b] Includes Elk and Coffey Counties.
[c] Includes Labette County.

Petroleum field report in 1910, by counties—Continued.

OKLAHOMA.

County.	Wells.						Acreage.		
	Productive Jan. 1.	Completed in 1910.		Abandoned.	Productive Dec. 31.	Drilling Dec. 31.	Fee.	Lease.	Total.
		Oil.	Dry.						
Atoka	4				4	10		6,000	6,000
Carter	23	12	2		35	1	1,830	6,482	8,312
Cherokee	32	5			37			530	530
Comanche	3				3	1		10,500	10,500
Craig	1				1		10	300	310
Creek	1,595	253	10	19	1,829	23	1,138	48,507	49,645
Garfield			1						
Johnston		1	6		1	1		1,140	1,140
Kiowa	5				5			1,120	1,120
Marshall	9	2	1	8	3		30	18,221	18,251
Muskogee	157	89	16	17	229	8	1,014	16,360	17,374
Nowata	4,171	657	44	48	4,780	10	5,111	74,580	79,691
Okmulgee	134	76	15	4	206	1	5,685	48,142	53,827
Osage	984	220	46	25	1,179	13		487,067	487,067
Pawnee	201	5	2	17	189		327	9,166	9,493
Pittsburg	4	3	4		7	7		3,855	3,855
Rogers	1,517	199	16	73	1,643	3	1,890	21,578	23,468
Sequoyah			1					4,000	4,000
Tulsa	823	215	16	28	1,010		1,280	39,555	40,835
Wagoner	1				1			3,847	3,847
Washington	2,223	457	23	86	2,594	13	4,741	445,227	449,968
Miscellaneous (undeveloped)								36,648	36,648
Total	11,887	2,194	203	325	13,756	91	23,056	1,282,825	1,305,881

LOUISIANA.

County.	Productive Jan. 1.	Oil.	Dry.	Abandoned.	Productive Dec. 31.	Drilling Dec. 31.	Fee.	Lease.	Total.
Acadia	98	19	5	26	91	3	641	1,766	2,407
Bossier						1			
Caddo	87	101	30	11	177	22	7,804	220,486	228,290
Calcasieu	9	10	10	1	18		2,346	1,734	4,080
St. Martin	4		1	2	2	1		50	50
St. Tammany			2					40,000	40,000
Miscellaneous (undeveloped)							1,200	706,006	707,206
Total	198	130	48	40	288	27	11,991	970,042	982,033

TEXAS.

County.	Productive Jan. 1.	Oil.	Dry.	Abandoned.	Productive Dec. 31.	Drilling Dec. 31.	Fee.	Lease.	Total.
Bexar	5				5			1,947	1,947
Brazoria	3	2	4	1	4	2	40,000		40,000
Brewster			1					10,000	10,000
Brown	5				5		40		40
Clay	150	15	17	2	163	2	5,744	416,355	422,099
Coleman	1				1			8,000	8,000
Dallas	3	3		3	3		4		4
Denton			2					3,000	3,000
Duval	4				4			250	250
Hardin	793	119	31	92	820		3,066	2,391	5,457
Harris	299	57	17	26	330	3	866	19,138	20,004
Henderson			2					5,000	5,000
Jefferson	122	34	14	30	126	2	89	1,142	1,231
Kaufman			3						
Lamar			2			1		25,000	25,000
Liberty	8		2	5	3		5	2,662	2,667
McLennan	12				12			360	360
McMullen	16				16			7,000	7,000
Marion		6	3		6		3,131	19,380	22,511
Matagorda	4	12	1	3	13	3	80	1,141	1,221
Navarro	952	63	25	20	995	1	2,193	63,794	65,987
Nueces			1					3,000	3,000
Reeves		1	1		1	1	850	9,000	9,850
Shelby			1						
Starr						1		14,000	14,000
Walker			1					2,500	2,500
Miscellaneous (undeveloped)							120	88,194	88,314
Total	2,377	312	128	182	2,507	16	56,188	703,254	759,442

CONSUMPTION OF FUEL OIL.

RAILROADS.

The following table shows that the consumption of fuel oil by the railroads of the United States is steadily increasing. During the year 1910 the quantity of fuel oil consumed amounted to 24,586,108 barrels, as compared with 19,939,394 barrels in 1909, an increase of 4,646,714 barrels, or 23.3 per cent. The average number of miles operated per barrel of oil consumed was 3.74. A few railroad companies, which have not begun the use of fuel oil in engines on the road, are using it in their roundhouses for stationary engines and boilers, and also for switching engines.

The increasing use of fuel oil is due to many causes. It has been demonstrated from tests made on some of the railroads accessible to the oil fields and refineries of the West, where fuel oil can be purchased cheaply, that the cost of operating with oil is less and its use equally as efficient as coal, the supplies of which are at times very low and uncertain on account of strikes and shutdowns of mines, and often on account of shortage of cars for the transportation of the coal, especially in the winter season. In some localities where oil is coming into use, as in Nevada, the cost of coal is extremely high. Another reason for the use of oil is the prevention or the elimination of forest fires, which in the last few years have been so disastrous in the northwestern part of the country. In addition to the economy of the use of oil as compared with coal on railroads, it is very much cleaner and safer for the traveler, there being no smoke or cinders.

In Technical Paper No. 3 of the United States Bureau of Mines Irving C. Allen has given specifications for the purchase of fuel oils for the United States Government.

Consumption of fuel oil by the railroads of the United States, 1906–1910.

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
1910	22,709	[e] 24,586,108	89,107,883	3.74

[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.
[e] Includes 768,762 barrels used for fuel other than for locomotives.

The following are the names of the railroad companies which used fuel oil on their lines in 1910: The Sunset Lines of California, Texas, and Louisiana, embracing the Southern Pacific Co. (Pacific System, excluding the Sonora Railway), 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, the St. Louis, San Francisco & Texas Railroad, and the St. Louis, Brownsville & Mexico Railway in Texas; 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 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; the Chicago & North Western Railway Co. and the Wyoming and Northwestern Railway Co., in Wyoming; the Northern Pacific Railway Co., between Seattle and Tacoma, in Washington; the Great Northern Railway Co. (engines and oil motor car); the Chicago, Milwaukee & Puget Sound Railway Co.; the Tonopah & Goldfield Railroad Co., in Nevada; and the New York Central & Hudson River Railroad in the Adirondacks, New York.

USE OF FUEL OIL IN THE UNITED STATES NAVY.

The engineering and military advantages of the use of fuel oil are clearly recognized by the Navy Department, as a result of experiment and experience. In the new construction fuel oil is being more and more extensively used. Torpedo boat destroyers Nos. 22–50 burn oil exclusively. Our eight most recent battleships, the *Delaware, North Dakota, Florida, Utah, Wyoming, Arkansas, Texas,* and *New York,* burn oil as auxiliary to coal. Battleships Nos. 36 and 37, authorized by the last Congress, will burn oil alone, and it is probable that subsequent battleships will be oil burners.

Oil is more expensive than coal in the ports frequented by our vessels, except the ports on the west coast of the United States. The distribution of oil at depots which would be available to the fleet in time of war is still unsatisfactory but is being developed.

Heavy oil engines.—It is regarded as probable that within a comparatively few years heavy oil engines of the Diesel type will be extensively adopted for marine propulsion, and particularly for naval vessels. There has been recently a remarkable development of this type of engine in Europe to an extent that renders it worthy of consideration for marine installations. Hitherto it has not merited such consideration on account of the limited power that could be developed in a single cylinder. An installation of any size required a multiplicity of cylinders. It now appears possible to obtain from 1,000 to 2,000 horsepower in a cylinder of moderate dimensions in an engine which is readily reversible and which will have a satisfactory speed control. The economy of the Diesel engine is twice that of the steam engine. Its weight and the space required for its installation will not be considerably less, but it permits the elimination of boiler and condenser, which have always been troublesome elements of machinery installations. Heavy oil engines are being installed in all submarines subsequent to No. 27, of which there are twelve, and the submarine tender authorized by the last Congress will have a heavy oil engine of about 1,600 horsepower.

Tanks for fuel oil.—Six steel tanks for fuel oil will be erected for the use of the Navy, one each at Bradford, R. I.; Norfolk, Va.; Charleston, S. C.; Key West, Fla.; Guantanamo, Cuba; and San Juan, P. R. These tanks will be 62 feet in diameter by 32 feet high. Six gasoline tanks 22 feet by 32 feet will also be erected. one at each of the stations mentioned.

CENSUS STATISTICS OF PETROLEUM REFINING IN 1909.

The Bureau of the Census has issued a preliminary statement, giving a summary of the principal results in regard to petroleum refining obtained in the census of manufactures for 1909 as compared with 1904.

It includes a summary comparing the general figures for 1904 and 1909 and a statement of the quantity of crude petroleum used; also the quantity of the principal products obtained therefrom. It was prepared under the direction of William M. Steuart, chief statistician for manufactures, Bureau of the Census. The figures are subject to such revision as may be necessary after a further examination of the original reports.

The word "establishment" as used in the Thirteenth Census is defined as meaning one or more factories, mills, or plants owned, controlled, or operated by a person, partnership, corporation, or other owner located in the same town or city and for which one set of books of accounts is kept.

Rates of increase.—The summary shows increases in all the items at the census of 1909 as compared with that for 1904, except for average number of wage earners and their wages.

The capital invested increased 33 per cent; the gross value of products, 35 per cent; cost of materials, 43 per cent; value added by manufacture, 6 per cent; number of salaried officials and clerks, 35 per cent; amount paid in salaries, 44 per cent; miscellaneous expenses, 78 per cent; primary horsepower, 96 per cent.

There were 147 manufacturing establishments in 1909 and 98 in 1904, an increase of 49, or 50 per cent.

The capital invested as reported in 1909 was $181,916,000, a gain of $45,635,000, or 33 per cent, over $136,281,000 in 1904. The average capital per establishment was approximately $1,237,000 in 1909 and $1,391,000 in 1904. In this connection it should be stated that in the census schedule the inquiry concerning capital invested calls for the total amount both owned and borrowed and invested in the business, but does not include the value of rented property, plant, or equipment which was employed in the conduct of manufacturing enterprises. In the final bulletins and reports there will be a separate statement of the rental paid for such property.

Value of products.—The value of products was $236,998,000 in 1909 and $175,005,000 in 1904, an increase of $61,993,000, or 35 per cent. The average per establishment was approximately $1,612,000 in 1909 and $1,786,000 in 1904.

The value of products represents the product as actually turned out by the factories during the census year and does not necessarily have any relation to the amount of sales for that year.

Cost of materials used.—The cost of materials used was $199,273,000 in 1909, as against $139,387,000 in 1904, an increase of $59,886,000, or 43 per cent. The average cost of materials per establishment was approximately $1,356,000 in 1909 and $1,422,000 in 1904. In addition to the component materials which enter into the products of the establishment for the census year there are included fuel, rent of power and heat, and mill supplies. The cost of materials, however, does not include unused materials and supplies bought either for speculation or for use during a subsequent period.

Value added by manufacture.—The value added by manufacture was $37,725,000 in 1909 and $35,618,000 in 1904, an increase of $2,107,000, or 6 per cent. This item formed 16 per cent of the total value of products in 1909 and 20 per cent in 1904. The value added by manufacture represents the difference between the cost of materials used and the value of products after the manufacturing processes have been expended upon them.

The miscellaneous expenses amounted to $9,445,000 in 1909 and $5,298,000 in 1904, an increase of $4,147,000, or 78 per cent. The average per establishment was approximately $64,000 in 1909 and $54,000 in 1904. Miscellaneous expenses include rent of factory or works, taxes, and amount paid for contract work, and these items, as well as such office and other expenses as can not be elsewhere classified, will appear separately in the final reports.

The salaries and wages amounted to $13,759,000 in 1909 and $12,713,000 in 1904, an increase of $1,046,000, or 8 per cent.

The number of salaried officials and clerks was 2,669 in 1909 and 1,974 in 1904, an increase of 695, or 35 per cent.

The average number of wage earners employed during the year was 13,929 in 1909 and 16,770 in 1904, a decrease of 2,841, or 17 per cent.

The amount paid in wages decreased 2 per cent. The decrease in number of wage earners and total wages is due to the fact that some of the largest refineries made separate reports in 1909 for their box, cooperage, and tinware shops, and the statistics for them have been included by the census as a part of these various industries. At the census of 1904 these operations were included in the report for the refineries.

The primary horsepower was 90,268 in 1909 and 46,019 in 1904, an increase of 44,249, or 96 per cent.

The average horsepower per establishment, considering all establishments, was approximately 614 horsepower in 1909 and 470 in 1904.

Quantity of crude oil and of principal products.—The number of 42-gallon barrels of crude petroleum used, as reported in 1909, was 120,775,439 and in 1904, 66,982,862, an increase of 53,792,577 barrels, or 80 per cent.

The kinds of crude oil used in 1909 were distributed in very different proportions from those in 1904. This change has materially affected the relative quantities of the various products.

The number of 50-gallon barrels of illuminating oils produced was 38,468,494 in 1909 and 27,135,094 in 1904, an increase of 11,333,400 barrels, or 42 per cent; of fuel oils, 34,034,577 in 1909 and 7,209,428 in 1904, an increase of 26,825,149 barrels, or 372 per cent; of lubricating oils, 10,745,885 in 1909 and 6,298,251 in 1904, an increase of 4,447,634 barrels, or 71 per cent; of lubricating and other greases, 138,302 in 1909 and 202,439 in 1904, a decrease of 64,137 barrels, or 32 per cent; of naphtha and gasoline, 11,903,159 in 1909 and 5,811,289 in 1904, an increase of 6,091,870 barrels, or 105 per cent; and of paraffin wax, 946,830 in 1909 and 794,068 in 1904, an increase of 152,762 barrels, or 19 per cent.

Comparative summaries follow, giving the general statistics for the industry, the quantity of crude petroleum used, and the quantity of the principal products, 1904 and 1909:

Petroleum refining—General summary: 1909 and 1904.

	Census—		Percentage of increase, 1904 to 1909.
	1909	1904	
Number of establishments	147	98	50
Capital	$181,916,000	$136,281,000	33
Cost of materials used	$199,273,000	$139,387,000	43
Salaries and wages	$13,759,000	$12,713,000	8
Salaries	$3,929,000	$2,724,000	44
Wages	$9,830,000	$9,989,000	a 2
Miscellaneous expenses	$9,445,000	$5,298,000	78
Value of products	$236,998,000	$175,005,000	35
Value added by manufacture (products less cost of materials)	$37,725,000	$35,618,000	6
Employees:			
Number of salaried officials and clerks	2,669	1,974	35
Average number of wage earners employed during the year	13,929	16,770	a 17
Primary horsepower	90,268	46,019	96

a Decrease.

Petroleum refining—Quantity of crude petroleum used, and of principal products: 1909 and 1904.

		Census—		Percentage of increase, 1904 to 1909.
		1909	1904	
Total quantity of crude petroleum used (barrels of 42 gallons)		120,775,439	66,982,862	80
PRINCIPAL PRODUCTS.				
Illuminating oils	Quantities (barrels of 50 gallons).	38,468,494	27,135,094	42
Fuel oils		34,034,577	7,209,428	372
Lubricating oils		10,745,885	6,298,251	71
Greases (lubricating, etc.)		138,302	202,439	a 32
Naphtha and gasoline		11,903,159	5,811,289	105
Paraffin wax		946,830	794,068	19

a Decrease.

Petroleum refining—Quantity of crude petroleum used, and of principal products: 1909 and 1904.

State.	Year.	Number of establishments.	Crude petroleum used (barrels of 42 gallons).	Principal products (barrels of 50 gallons).						
				Oils.			Greases (lubricating, etc.).	Naphtha and gasoline.	Paraffin wax.	
				Illuminating.	Fuel.	Lubricating.				
									Barrels.	*Pounds.*
United States	1909	147	120,775,439	38,468,494	34,034,577	10,745,885	138,302	11,903,159	946,830	355,061,250
	1904	98	66,982,862	27,135,094	7,209,428	6,298,251	202,439	5,811,289	794,068	297,775,500
California	1909	29	13,481,085	1,728,863	3,931,366	186,672	10,130	628,804	....	....
	1904	19	4,369,600	647,934	731,215	54,018	23,875	238,015	3,898	1,461,750
Colorado [a]	1909	4	346,209	96,617	57,183	(b)	....	18,061	(b)	....
Illinois [c]	1909	8	3,983,601	850,918	1,336,126	118,584	....	492,175	(d)	....
Kansas [a]	1909	18	4,063,270	704,845	2,071,210	82,596	1,945	387,874	3,171	1,189,125
Ohio	1909	10	4,833,675	1,204,186	1,257,950	543,526	18,076	539,828	54,536	20,451,000
	1904	12	4,195,871	1,317,116	643,989	336,116	19,659	467,594	47,533	17,824,875
Oklahoma [c]	1909	9	1,078,286	245,109	409,284	(d)	....	125,179	....	....
Pennsylvania	1909	41	21,893,871	13,632,184	2,712,073	3,124,921	(d)	3,147,727	326,809	122,553,375
	1904	43	17,977,686	8,328,883	1,648,535	1,870,437	88,085	1,774,626	279,511	104,816,625
All other States [e]	1909	28	71,095,442	20,005,772	22,259,385	6,689,586	108,151	6,563,511	562,314	210,867,750
	1904	24	40,439,705	16,841,161	4,185,689	4,037,680	70,820	3,331,054	463,126	173,672,250

[a] In "all other States" in 1904.
[b] Product of one establishment; can not be shown without disclosing individual operations.
[c] Nothing reported in 1904.
[d] Product of two establishments; can not be shown without disclosing individual operations.
[e] Includes in 1909, establishments distributed as follows: Indiana, 1; Kentucky, 1; Louisiana, 2; Maryland, 2; Missouri, 1; New Jersey, 6; New York, 7; Texas, 8; in 1904: Colorado, 2; Indiana, 1; Kansas, 1; Louisiana, 1; Maryland, 1; New Jersey, 4; New York, 5; Texas, 7; West Virginia, 1; Wyoming, 1.

The following table shows the percentage of principal products obtained in refining per barrel of crude oil in 1909 and 1904:

Per cent of principal products obtained per barrel of crude oil in 1909 compared with 1904.

State.	Year.	Naphtha and gasoline.	Illuminating oil.	Lubricating oil.	Greases, etc.	Paraffin wax.	Fuel oil.	Other products and loss.
United States	1909	11.73	37.92	10.59	0.14	0.93	33.55	5.14
	1904	10.33	48.22	11.19	.36	1.41	12.82	5.67
California	1909	5.55	15.27	1.65	.09	....	34.72	a 42.72
	1904	6.48	17.65	1.47	.65	.11	19.92	a 53.72
Colorado	1909	6.21	33.22	....	....	....	19.66	a 40.91
Illinois	1909	14.71	25.43	3.54	....	....	39.93	a 16.39
Kansas	1909	11.36	20.65	2.42	.06	.09	60.68	4.74
Ohio	1909	13.30	29.66	13.39	.45	1.34	30.98	10.88
	1904	13.27	37.37	9.54	.56	1.35	18.27	9.64
Oklahoma	1909	13.82	27.06	....	....	....	45.19	13.94
Pennsylvania	1909	17.12	74.12	16.99	....	1.78	14.75	(b)
	1904	11.76	55.15	12.39	.58	1.85	10.92	7.35
All other States	1909	10.99	33.50	11.20	.18	.94	37.27	5.92
	1904	9.81	49.58	11.89	.21	1.36	12.32	a 14.83

a Includes asphalt, etc. b Includes rerun manufactured products.

APPALACHIAN OIL FIELD.

PRODUCTION.

In spite of declines in Pennsylvania, New York, and Kentucky, the total production of the Appalachian oil field showed an increase of 355,535 barrels, due to activity in West Virginia and southeastern Ohio.

The following table gives the production of petroleum in the Appalachian oil field during the year 1910, by States and months:

Production of the Appalachian oil field, by States and months, in 1910, in barrels.

Month.	Pennsylvania.	New York.	Southeastern Ohio.	West Virginia.	Kentucky.	Total.
January	721,627	90,027	395,160	1,026,338	40,984	2,274,136
February	621,467	71,699	355,016	935,152	35,795	2,019,129
March	851,225	101,406	451,068	1,050,063	41,006	2,494,768
April	766,700	92,245	435,057	962,557	39,907	2,296,466
May	759,585	90,581	454,628	1,001,646	43,055	2,349,495
June	790,520	92,064	436,580	1,018,594	44,239	2,381,997
July	723,646	89,457	401,193	984,713	40,009	2,239,018
August	763,273	89,650	412,014	1,020,217	40,699	2,325,853
September	720,165	86,428	384,210	976,120	41,017	2,207,940
October	708,453	86,659	382,105	935,066	35,822	2,148,105
November	678,132	79,519	353,519	906,421	29,144	2,046,735
December	689,869	84,103	361,684	934,984	37,097	2,107,737
Total	8,794,662	1,053,838	4,822,234	11,751,871	468,774	26,891,379

The production of petroleum in the Appalachian oil field from 1859 to 1910, inclusive, is given in the following table:

Production of petroleum in the Appalachian field, 1859–1910, 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	$0.87⅞
1860	500,000	100	+ 498,000	9.59	1886	26,549,827	94.60	+5,016,042	.71¼
1861	2,113,609	100	+1,613,609	.49	1887	22,878,241	80.90	−3,671,586	.66¾
1862	3,056,690	100	+ 943,081	1.05	1888	16,941,397	61.36	−5,936,844	.87⅝
1863	2,611,309	100	+ 445,381	3.15	1889	22,355,225	63.57	+5,413,828	.94⅛
1864	2,116,109	100	− 495,200	8.06	1890	30,073,307	65.63	+7,718,082	.86¾
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	.55⅝
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	3.62½	1894	30,783,424	62.38	− 582,466	.83⅞
1869	4,215,000	100	+ 568,883	5.63¾	1895	30,960,639	58.54	+ 177,215	1.35⅞
1870	5,260,745	100	+1,045,745	3.86	1896	33,971,902	55.73	+3,010,263	1.17⅞
1871	5,205,234	100	− 55,511	4.34	1897	35,230,271	58.25	+1,258,369	.78⅝
1872	6,293,194	100	+1,087,960	3.64	1898	31,717,425	57.29	−3,512,846	.91⅛
1873	9,893,786	100	+3,600,592	1.83	1899	33,068,356	57.94	+1,350,931	1.29⅜
1874	10,926,945	100	+1,033,159	1.17	1900	36,295,433	57.05	+3,227,077	1.35¼
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	2.56¼	1902	32,018,787	36.07	−1,599,384	1.23¾
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	1.62¾
1879	19,894,288	99.90	+4,512,647	.85⅞	1905	29,366,960	21.80	−2,041,607	1.39⅜
1880	26,245,571	99.85	+6,351,283	.94½	1906	27,741,472	21.93	−1,625,488	1.59¾
1881	27,561,376	99.64	+1,315,805	.85⅞	1907	25,342,137	15.26	−2,399,335	1.74½
1882	30,221,261	99.58	+2,659,885	.78⅛	1908	24,945,517	13.97	− 396,620	1.78
1883	23,306,776	99.39	−6,914,485	1.05¾	1909	26,535,844	14.49	+1,590,327	1.64⅝
1884	23,956,438	98.92	+ 649,662	.83½	1910	26,891,379	12.83	+ 355,535	1.33⅝

[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 1909 and 1910, 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 1909 and 1910, by States, showing increase or decrease and percentage of increase or decrease, in barrels.

State.	Production.		Increase.	Decrease.	Percentage.	
	1909	1910			Increase.	Decrease.
Pennsylvania	9,299,403	8,794,662		504,741		5.43
New York	1,134,897	1,053,838		81,059		7.14
Southeastern Ohio	4,717,436	4,822,234	104,798		2.22	
West Virginia	10,745,092	11,751,871	1,006,779		9.37	
Kentucky	639,016	468,774		170,242		26.64
Total	26,535,844	26,891,379	355,535		1.34	

In the following table are given the quantity, value, and price per barrel of the oil produced in the Appalachian field during the years 1909 and 1910, by States:

Quantity and value at wells of petroleum produced in the Appalachian field in 1909 and 1910, by States.

State.	1909			1910		
	Quantity, in barrels.	Value.	Price per barrel.	Quantity, in barrels.	Value.	Price per barrel.
Pennsylvania	9,299,403	$15,424,554	$1.659	8,794,662	$11,908,914	$1.354
New York	1,134,897	1,878,217	1.655	1,053,838	1,414,668	1.342
Southeastern Ohio	4,717,436	7,773,880	1.648	4,822,234	6,469,939	1.342
West Virginia	10,745,092	17,642,283	1.642	11,751,871	15,720,184	1.338
Kentucky	639,016	518,299	.811	468,774	324,684	.693
Total	26,535,844	43,237,233	1.629	26,891,379	35,838,389	1.333

Production and value of petroleum in the Appalachian field, 1901–1910, by States, in barrels.

Year.	Pennsylvania.		New York.		Southeastern Ohio.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
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
1910	8,794,662	11,908,914	1,053,838	1,414,668	4,822,234	6,469,939

Year.	West Virginia.		Kentucky-Tennessee.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
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	a 727,767	706,811	24,945,517	43,888,020
1909	10,745,092	17,642,283	a 639,016	518,299	26,535,844	43,237,233
1910	11,751,871	15,720,184	a 468,774	324,684	26,891,379	35,838,389

a No production in Tennessee recorded.

In the two following tables is given the production of petroleum in the Appalachian field from 1906 to 1910—in the first by months and in the second by days:

Production of petroleum in the Appalachian oil field, 1906–1910, by months and years, in barrels.

Month.	1906	1907	1908	1909	1910
January	2,346,346	2,064,855	1,968,724	1,989,577	2,274,136
February	2,070,728	1,938,474	1,873,646	1,906,109	2,019,129
March	2,397,601	2,186,092	2,105,483	2,237,778	2,494,768
April	2,326,650	2,169,518	2,072,861	2,158,382	2,296,466
May	2,473,788	2,254,810	2,120,427	2,194,631	2,349,495
June	2,383,010	2,082,385	2,182,340	2,220,971	2,381,997
July	2,406,191	2,245,920	2,172,802	2,306,654	2,239,018
August	2,437,028	2,155,226	2,098,144	2,273,277	2,325,853
September	2,198,899	2,021,582	2,120,175	2,288,067	2,207,940
October	2,329,121	2,138,189	2,103,249	2,309,898	2,148,105
November	2,180,492	1,947,011	1,938,239	2,321,230	2,046,735
December	2,191,618	2,138,075	2,189,427	2,329,270	2,107,737
Total	27,741,472	25,342,137	24,945,517	26,535,844	26,891,379

Average daily production of petroleum in the Appalachian oil field each month, 1906–1910, by months and years, in barrels.

Month.	1906	1907	1908	1909	1910
January	75,689	66,608	63,507	64,180	73,359
February	73,955	69,231	64,608	68,075	72,112
March	77,342	70,519	67,919	72,186	80,476
April	77,555	72,317	69,095	71,946	76,549
May	79,798	72,736	68,401	70,795	75,790
June	79,434	69,413	72,745	74,032	79,400
July	77,619	72,449	70,090	74,408	72,226
August	78,614	69,523	67,682	73,332	75,028
September	73,297	67,386	70,673	76,269	73,598
October	75,133	68,974	67,847	74,513	69,294
November	72,683	64,903	64,608	77,374	68,225
December	70,697	68,970	70,627	75,138	67,992
Average	76,004	69,430	68,157	72,701	73,675

PIPE-LINE STATISTICS FOR 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 1910, 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, 1910, by lines and months, in barrels.

Month.	National Transit.	Southwest.	Eureka.	Cumberland.	New York Transit.	Tidewater.
January	322,992	121,756	967,987	40,405	16,692	119,047
February	270,014	120,516	873,950	35,251	12,153	97,898
March	389,790	149,306	980,914	40,517	19,510	138,453
April	347,877	136,247	895,975	39,396	17,324	123,623
May	340,879	136,414	935,879	42,566	16,374	123,515
June	346,255	150,208	959,202	43,897	18,047	126,856
July	317,674	131,442	925,390	39,495	15,476	119,914
August	326,645	149,487	961,469	40,200	16,790	125,345
September	309,168	132,706	914,113	40,627	16,722	117,128
October	299,974	135,022	873,948	35,481	16,135	116,454
November	285,357	132,790	851,838	28,894	15,003	108,689
December	282,879	140,561	874,232	36,797	16,542	113,872
Total	3,839,504	1,636,455	11,014,897	463,526	196,768	1,430,794

Month.	Producers and Refiners.	Emery.	Buckeye Macksburg.	Franklin.	Other lines.	Total.
January	190,906	30,217	325,694	3,499	134,941	2,274,136
February	173,469	23,752	293,641	2,318	116,167	2,019,129
March	211,658	31,747	376,446	5,081	151,346	2,494,768
April	197,545	30,683	364,049	4,002	139,745	2,296,466
May	196,615	28,328	385,779	3,496	139,650	2,349,495
June	191,770	31,125	367,889	4,159	142,589	2,381,997
July	185,406	28,540	335,113	3,224	137,344	2,239,018
August	188,308	29,802	345,167	3,760	138,880	2,325,853
September	191,655	28,576	317,654	3,346	136,245	2,207,940
October	190,554	29,614	313,706	3,859	133,358	2,148,105
November	177,804	27,084	286,779	3,452	129,045	2,046,735
December	184,319	29,057	293,229	3,108	133,141	2,107,737
Total	2,280,009	348,525	4,005,146	43,304	1,632,451	26,891,379

Pipe-line deliveries in the Appalachian oil field in 1910, by lines and months, in barrels.

Month.	National Transit.	Southwest.	Eureka.	Cumberland.	Southern.	Crescent.	New York Transit.
January	1,488,682	165,459	83,866	1,631	642,422	155,299	1,499,615
February	1,626,507	145,001	70,797	778	442,943	145,781	1,248,859
March	1,700,142	171,743	59,549	912	521,505	148,259	1,450,109
April	1,681,321	156,170	64,664	1,890	676,661	138,452	1,742,708
May	1,684,950	149,308	67,551	35,526	570,444	201,451	1,578,844
June	1,534,899	138,796	87,719	6,284	597,990	169,319	1,469,527
July	1,562,721	140,836	88,233	4,733	583,159	102,007	1,581,347
August	1,551,961	153,720	77,854	9,106	643,407	166,781	1,489,003
September	1,619,367	156,405	87,464	3,997	602,669	194,903	1,047,098
October	1,719,919	161,915	81,178	2,186	583,457	163,766	1,308,114
November	1,715,377	152,703	72,868	2,146	564,100	122,209	1,381,955
December	1,629,274	164,461	72,197	669	565,030	157,729	[a] 1,380,843
Total	19,515,120	1,856,517	913,940	69,858	6,993,787	1,865,956	[a] 17,178,022

Month.	Tidewater.[b]	Producers and Refiners.	Emery.	United States.	Buckeye Macksburg.	Franklin.	Other lines.[b]	Total.
January	151,084	159,415	29,396	72,132	7,448	4,651	147,590	4,608,690
February	151,084	139,017	24,524	57,524	6,199	4,718	147,590	4,211,322
March	151,084	187,725	29,491	58,047	3,028	1,999	147,590	4,631,183
April	151,084	199,744	32,027	70,493	4,511	....	147,590	5,067,315
May	151,084	216,631	28,373	75,731	6,555	....	147,590	4,914,038
June	151,084	236,750	31,337	67,583	4,477	....	147,590	4,643,355
July	151,085	224,182	27,884	72,971	2,078	....	147,590	4,688,826
August	151,085	204,631	30,896	73,348	5,036	2	147,590	4,704,420
September	151,084	183,640	28,154	66,132	1,208	488	147,590	4,290,199
October	151,084	183,746	28,173	60,790	3,307	4,729	147,590	4,599,954
November	151,084	165,186	29,483	71,604	3,090	3,624	147,590	4,583,019
December	151,084	162,552	25,982	61,957	3,555	11,818	147,590	4,534,741
Total	1,813,010	2,263,219	345,720	808,312	50,492	32,029	1,771,080	55,477,062

[a] Includes 267 barrels delivered by Northern Pipe Line Co. [b] Averaged.

Gross stocks held by pipe lines in the Appalachian oil field at close of each month, in 1910, in barrels.

Month.	National Transit.	Southwest.	Eureka.	Cumberland.	Southern.	Crescent.	New York Transit.	Tidewater.
January	1,983,730	985,541	1,536,190	326,799	773,449	127,907	2,613,588	771,803
February	1,767,981	998,359	1,563,739	360,961	851,590	122,063	2,719,067	709,439
March	1,910,091	1,023,216	1,417,513	390,637	941,542	122,212	2,912,257	707,495
April	1,711,066	1,179,148	1,319,636	385,051	750,989	128,774	2,666,912	680,862
May	1,761,797	1,129,255	1,216,523	367,155	754,364	80,165	2,666,049	650,416
June	1,805,308	1,059,747	1,222,467	372,703	857,058	65,900	2,684,191	622,119
July	1,834,565	940,059	1,169,818	342,522	969,566	123,939	2,737,536	590,369
August	1,752,297	1,084,963	1,169,996	340,078	992,820	116,258	2,588,824	573,100
September	1,666,294	976,381	1,355,058	315,508	981,674	78,598	2,094,782	537,883
October	1,742,160	892,338	1,262,375	285,229	890,190	668,879	2,089,236	487,487
November	1,683,951	936,352	1,114,263	258,656	889,745	89,755	1,997,600	429,775
December	1,775,101	740,814	1,327,271	266,462	872,810	867,751	2,033,416	363,063

Month.	Northern.	Producers and Refiners.	Emery.	United States.	Buckeye Macksburg.	Franklin.	Other pipe lines.	Total.
January	1,222,716	242,655	11,155	56,651	283,423	47,285	....	....
February	1,356,076	277,107	10,383	51,616	301,757	44,317	....	....
March	1,337,957	301,040	12,639	58,816	319,918	46,832	....	....
April	1,166,117	298,841	11,295	53,973	301,919	50,263	....	....
May	1,045,614	278,825	11,250	52,930	256,080	53,192	....	....
June	1,292,241	233,845	11,038	54,939	266,357	56,784	....	....
July	1,246,265	195,068	11,695	55,557	260,625	59,441	....	....
August	1,163,262	178,745	10,601	51,976	271,920	62,631	....	....
September	1,084,404	186,760	11,024	53,417	258,666	64,923	....	....
October	904,696	193,569	12,464	56,589	261,136	63,486	....	....
November	993,203	206,187	10,065	52,819	260,820	62,746	....	....
December	859,201	228,581	13,140	55,832	274,687	53,470	71,553	9,022,152

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 1909 and 1910:

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 1909 and 1910, per barrel of 42 gallons.

Date.	Pennsylvania and Tiona, Pa.	Mercer black, Pennsylvania.	Corning, Ohio.	New Castle, Ohio.	Cabell, W. Va.
1909.					
Jan. 1	$1.78	....	$1.14	$1.22	$1.32
Mar. 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
Oct. 21	1,53	1.00	.89	.97	1.07
Nov. 6	1.48	.95	.84	.92	1.02
Dec. 9	1.43	.90	.79	.87	.97
1910.					
Jan. 1	1.43	.90	.79	.87	.97
Jan. 7	1.40	.90	.79	.87	.97
Apr. 8	1.35	.90	.79	.87	.97
June 11	1.30	.87	.77	.84	.94

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 1909 and 1910:

Average monthly prices of Appalachian petroleum in 1909 and 1910, per barrel.

Month.	Pennsylvania and Tiona, Pa.	Mercer black, Pennsylvania.	Corning, Ohio.	New Castle, Ohio.	Cabell, W. Va.
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
1910.					
January	1.40½	.90	.79	.87	.97
February	1.40	.90	.79	.87	.97
March	1.40	.90	.79	.87	.97
April	1.36⅛	.90	.79	.87	.97
May	1.35	.90	.79	.87	.97
June	1.31¾	.88	.77¾	.85	.95
July	1.30	.87	.77	.84	.94
August	1.30	.87	.77	.84	.94
September	1.30	.87	.77	.84	.94
October	1.30	.87	.77	.84	.94
November	1.30	.87	.77	.84	.94
December	1.30	.87	.77	.84	.94
Average	1.33⅝	.88¼	.77⅞	.85¼	.95¼

The average monthly and yearly prices per barrel of Pennsylvania petroleum at wells in the years 1901–1910 are given in the following table:

Monthly and yearly average prices of pipe-line certificates of Pennsylvania petroleum at wells in daily market, 1901–1910, per barrel.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average.
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
1910	1.40½	1.40	1.40	1.36⅛	1.35	1.31¾	1.30	1.30	1.30	1.30	1.30	1.30	1.33⅝

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, 1859–1910, 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

Highest and lowest prices of Pennsylvania crude petroleum each year, 1859–1910, per barrel—Continued.

Year.	Highest.		Lowest.	
	Month.	Price.	Month.	Price.
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
1910	January	1.43	June to December, inclusive	1.30

PENNSYLVANIA AND NEW YORK.

PENNSYLVANIA.

Decline in the Pennsylvania and New York field, the oldest in the United States, was less than at the rate expected. The production in Pennsylvania amounted to 8,794,662 barrels, valued at $11,908,914; in 1909 the production was 9,299,403 barrels, valued at the higher price then prevailing, at $15,424,554. The slow rate of decline is due to the remarkable thrift of the small producers who find it still profitable to operate leases where the production is one-sixth of a barrel a day and sometimes even less. This is true particularly in the northern pools of the State. Many of the producing wells were drilled more than 30 years ago. The operating expenses include besides pumper's wages, the upkeep of a boiler, a "power" for pumping a group of wells from the central station, the repairs to connecting rods and to pumps, valves, and an occasional cleaning out of the wells. Recently very intelligently conducted experiments have been in progress, by which air has been fed to a gasoline flame maintained near the bottom of the wells for the purpose of heating the rock and melting or dissolving out accumulations of paraffin wax tending to clog the pores. Sufficient heat has been obtained by this means to melt the ends of the pipes, but the experiments have not yet been finished and the value of the process can not yet be estimated. Considerable economy is claimed for transmitting the power from the central station to the individual wells by means of compressed air instead of rods, and the distance to which power can be efficiently transmitted has undoubtedly been so greatly increased, with any desired changes of direction, that plants costing $8,000 have been installed at several places in the old fields. The spraying process of operating wells by compressed air has also been tried. An objection seems to be the great rusting of the pipes when air is introduced into wells containing salt water. Great interest was manifested during the year in the separation of natural gasoline from casing-head gas.

NEW YORK.

The decrease in production in New York has continued, the output in 1910 being 1,053,838 barrels, as compared with 1,134,897 barrels in 1909, a decrease of 7.14 per cent—a rate of decline greater than in Pennsylvania.

PRODUCTION.

The following table shows the production of petroleum in Pennsylvania and New York, 1906–1910, by months:

Production of petroleum in Pennsylvania and New York in 1906–1910, by months, in barrels.

Month.	Pennsylvania.				
	1906	1907	1908	1909	1910
January	863,084	824,081	782,683	759,178	721,627
February	745,599	742,149	718,905	704,391	621,467
March	860,932	874,478	835,990	822,600	851,225
April	871,464	847,748	803,590	784,155	766,700
May	910,711	875,529	805,930	818,359	759,585
June	884,651	826,192	819,020	820,155	790,520
July	871,792	900,025	806,003	792,327	723,646
August	887,274	842,609	781,988	786,563	763,273
September	822,898	799,053	786,963	774,750	720,165
October	881,790	852,446	781,001	758,779	708,453
November	836,245	779,009	710,246	765,504	678,132
December	820,453	835,987	792,006	712,642	689,869
Total	10,256,893	9,999,306	9,424,325	9,299,403	8,794,662

Month.	New York.				
	1906	1907	1908	1909	1910
January	103,492	100,887	98,776	95,270	90,027
February	94,432	89,502	87,119	89,526	71,699
March	103,077	105,662	99,948	100,008	101,406
April	101,492	102,975	100,511	96,249	92,245
May	110,492	107,406	97,365	98,490	90,581
June	105,964	98,809	99,954	99,905	92,064
July	105,837	106,231	99,338	96,247	89,457
August	109,169	102,093	95,754	93,900	89,650
September	101,130	98,236	96,299	93,583	86,428
October	106,621	103,308	98,556	90,382	86,659
November	103,749	96,772	89,345	91,058	79,519
December	98,062	100,419	97,163	90,279	84,103
Total	1,243,517	1,212,300	1,160,128	1,134,897	1,053,838

WELL RECORD.

The following tables give the well records for Pennsylvania and New York from 1906 to 1910, inclusive:

Number of wells completed in the Pennsylvania and New York oil fields, 1906–1910, by districts.

District.	Completed.					Dry.					Productive.				
	1906	1907	1908	1909	1910	1906	1907	1908	1909	1910	1906	1907	1908	1909	1910
Bradford	332	305	359	571	344	35	37	44	36	28	297	268	315	535	316
Allegany	635	581	473	459	283	73	89	66	40	64	562	492	407	419	219
Middle	674	563	620	506	235	123	136	89	65	40	551	427	531	441	195
Venango and Clarion	1,905	1,997	1,841	1,881	790	253	217	201	199	155	1,652	1,780	1,640	1,682	635
Butler and Armstrong	475	435	520	487	263	161	164	204	178	111	314	271	316	309	152
Southwest Pennsylvania	451	451	347	319	286	161	205	153	145	130	290	246	194	174	156
Total	4,472	4,332	4,160	4,223	2,201	806	848	757	663	a 528	3,666	3,484	3,403	3,560	1,673

a Includes 243 gas wells.

Number of wells completed in the Pennsylvania and New York oil fields, 1906–1910, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
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
1910	147	132	109	190	266	250	222	211	179	182	188	125	2,201

Number of dry holes drilled in the Pennsylvania and New York oil fields, 1906–1910, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
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
1910	33	38	27	45	53	58	52	53	39	46	42	42	[a] 528

[a] Includes 243 gas wells.

Total and average initial daily production of new wells in the Pennsylvania and New York oil fields, 1906–1910, by districts, in barrels.

District.	Total initial production.					Average initial production per well.				
	1906	1907	1908	1909	1910	1906	1907	1908	1909	1910
Bradford	867	632	874	1,345	952	2.92	2.36	2.77	2.51	3.01
Allegany	1,547	1,147	806	815	368	2.75	2.33	1.98	1.94	1.68
Middle	1,833	1,378	1,257	977	442	3.33	3.23	2.37	2.22	2.27
Venango and Clarion	5,717	5,779	4,052	4,573	1,276	3.46	3.25	2.47	2.72	2.00
Butler and Armstrong	1,688	1,579	1,532	2,493	1,489	5.37	5.83	4.85	8.07	9.80
Southwest Pennsylvania	4,770	2,636	1,383	1,130	2,156	16.45	10.71	7.13	6.49	13.82
Total	16,422	13,151	9,904	11,333	6,683	4.48	3.77	2.91	3.18	3.99

Total initial daily production of new wells in the Pennsylvania and New York oil fields, 1906–1910, by months, in barrels.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
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
1910	572	320	211	584	1,355	621	604	924	353	395	448	296	6,683

WEST VIRGINIA.

PRODUCTION.

The production of the Shinnston pool in Harrison County, the center of interest in 1909, declined sharply to 3,000 barrels a day in 1910. This was in spite of repeated agitation and vigorous efforts to extend the pool. Prospecting was quite active in many localities in the State, especially in Roane, Tyler, and Ritchie counties. The net result for the State was an increase from 10,745,092 barrels in 1909 to 11,751,871 barrels in 1910. Details are given in the tables which follow.

In the following table is given the production of petroleum in West Virginia in the years 1906 to 1910, by months:

Total production of petroleum in West Virginia, 1906–1910, by months, in barrels.

Month.	1906	1907	1908	1909	1910
January	832,628	687,251	697,040	735,379	1,026,338
February	752,399	695,616	700,103	722,045	935,152
March	897,277	771,814	770,689	851,002	1,050,063
April	833,514	770,274	779,089	833,432	962,557
May	923,039	821,554	823,144	829,833	1,001,646
June	872,138	747,071	870,289	870,909	1,018,594
July	917,879	812,437	864,877	904,745	984,713
August	906,522	785,620	815,242	923,438	1,020,217
September	777,682	734,077	803,139	950,188	976,120
October	833,781	765,671	795,539	997,295	935,066
November	762,915	696,694	739,605	1,016,738	906,421
December	811,161	807,217	864,420	1,110,088	934,984
Total	10,120,935	9,095,296	9,523,176	10,745,092	11,751,871

The quantity and value of petroleum produced in West Virginia from 1901 to 1910, inclusive, are shown in the following table:

Quantity and value of petroleum produced in West Virginia, 1901–1910.

Year.	Regular crude.			Lubricating crude.			Total.		
	Quantity.	Value.	Price per barrel.	Quantity.	Value.	Price per barrel.	Quantity.	Value.	Price per barrel.
	Barrels.			*Barrels.*			*Barrels.*		
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
1910	11,751,018	15,717,796	1.338	853	2,388	2.80	11,751,871	15,720,184	1.338

WELL RECORD.

The following tables give the well records for West Virginia from 1906 to 1910, inclusive:

Number of wells completed in West Virginia in 1910, 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	4	2	3	....	....	18	47	2	......	18	32	1	14	3	2	146
February	5	....	1	3	1	19	41	2	7	10	17	....	11	3	3	123
March	4	3	2	1	....	8	33	1	9	13	23	1	18	4	2	122
April	5	2	....	4	....	17	49	1	13	10	21	2	14	6	2	146
May	2	2	2	1	1	13	48	....	10	24	28	2	6	8	6	153
June	2	8	2	4	1	19	48	1	17	14	22	....	9	8	2	157
July	1	2	3	4	1	12	40	....	20	14	28	....	12	9	2	148
August	....	1	....	4	....	7	39	....	14	14	29	....	13	4	4	129
September	2	1	....	1	1	11	43	....	17	13	23	1	14	4	6	137
October	....	4	....	....	2	7	49	....	11	12	18	2	15	7	5	132
November	1	2	3	....	....	10	32	....	13	12	7	....	16	8	4	108
December	....	3	1	2	....	7	31	....	10	5	21	1	20	11	3	115
Total	26	30	17	24	7	148	500	7	141	159	269	10	162	75	41	1,616
Total, 1909	97	60	14	39	24	317	466	11	142	163	208	50	137	106	23	1,857

Number of wells completed in West Virginia, 1906–1910, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
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
1910	146	123	122	146	153	157	148	129	137	132	108	115	1,616

Number of dry holes drilled in West Virginia in 1910, 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	3	....	1	....	....	3	15	....	....	6	12	....	4	....	2	46
February	4	....	....	1	....	3	16	....	1	4	6	....	3	1	3	42
March	3	1	2	....	....	2	16	....	3	6	6	....	7	1	2	49
April	4	1	....	2	....	3	35	....	4	4	9	2	8	3	2	77
May	2	....	1	1	1	....	31	....	2	7	8	....	4	2	5	64
June	....	2	2	2	....	2	30	1	6	5	7	....	6	3	2	68
July	1	....	3	4	....	....	28	....	4	8	7	....	7	4	1	67
August	....	1	....	1	....	....	25	....	6	5	10	....	10	2	4	64
September	1	1	....	....	1	....	25	....	5	3	6	....	10	1	6	59
October	....	....	....	....	....	1	30	....	3	3	7	1	11	2	4	62
November	1	1	1	....	....	....	27	....	3	2	1	....	14	2	2	54
December	....	1	1	2	....	1	23	....	7	1	2	....	16	10	3	67
Total	19	8	11	13	2	15	301	1	44	54	81	3	100	31	36	[a]719
Total, 1909	35	12	10	15	13	83	264	4	51	52	39	16	73	34	22	[b]723

[a] Includes 436 gas wells. [b] Includes 357 gas wells.

Number of dry holes drilled in West Virginia, 1906–1910, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
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
1910	46	42	49	77	64	68	67	64	59	62	54	67	[a] 719

[a] Includes 436 gas wells.

Initial daily production of new wells completed in West Virginia in 1910, 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	5	5	10	......	....	323	2,919	15	......	206	416	6	600	18	....	4,523
February	8	......	3	3	2	350	2,169	10	13	285	312	....	398	6	....	3,559
March	10	10	....	30	....	145	560	5	97	583	325	5	309	13	....	2,092
April	8	3	....	135	....	235	922	5	88	302	285	....	68	43	....	2,094
May	......	6	2	......	....	247	640	....	38	588	408	30	30	81	15	2,085
June	20	13	....	15	2	390	955	....	188	554	338	....	50	8	....	2,533
July	......	10	....	......	1	175	640	....	190	97	423	....	55	46	10	1,647
August	......	......	....	12	....	115	446	....	68	227	485	....	130	17	....	1,500
September	8	......	....	1	....	129	1,950	....	55	114	287	5	26	33	....	2,608
October	......	11	....	......	2	69	613	....	32	381	202	80	37	105	10	1,542
November	......	3	13	......	....	137	570	....	275	221	125	....	27	27	10	1,408
December	......	8	....	......	....	82	42	....	6	63	360	15	22	5	....	603
Total	59	69	28	196	7	2,397	12,426	35	1,050	3,621	3,966	141	1,752	402	45	26,194
Total, 1909	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, 1906–1910, by months, in barrels.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.	Average.
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
1910	4,523	3,559	2,092	2,094	2,085	2,533	1,647	1,500	2,608	1,542	1,408	603	26,194	2,183

KENTUCKY AND TENNESSEE.

PRODUCTION.

In Kentucky strenuous effort, with partial success, was made to extend the West Virginia pools over into Lawrence County. The old producing region was actively prospected, especially in Wayne County, and considerable attention was paid to the western part of the State in the effort to extend the Indiana pools into Kentucky.

Much leasing has been carried on in Warren, Muhlenberg, Hopkins, Webster, Henderson, Meade, and adjoining counties, and test wells were begun in Webster and Henderson counties. The detailed statistics by counties are given below.

In Tennessee little activity was evident, except wildcatting in connection with gas seeps in the western part of the State. Production in Kentucky declined from 639,016 barrels in 1909 to 468,774 barrels in 1910, or over 26 per cent.

In the following table is given the production of petroleum in Kentucky and Tennessee, by months, from 1906 to 1910, inclusive:

Production of petroleum in Kentucky and Tennessee, by months, 1906–1910, in barrels.

Month.	1906	1907	1908	1909	1910
January	115,317	77,034	60,781	59,799	40,984
February	101,084	67,939	60,168	56,355	35,795
March	109,351	78,438	59,336	63,085	41,006
April	103,690	73,467	63,283	55,681	39,907
May	102,224	72,728	65,927	57,065	43,055
June	106,005	64,120	60,127	53,522	44,239
July	106,708	66,940	60,150	55,414	40,009
August	106,936	66,131	60,533	54,777	40,699
September	96,561	66,493	60,137	54,221	41,017
October	94,385	65,142	55,385	46,330	35,822
November	88,483	60,860	59,643	41,772	29,144
December	82,804	61,552	62,297	40,995	37,097
Total	1,213,548	820,844	[a] 727,767	[a] 639,016	[a] 468,774

[a] No production in Tennessee recorded.

Pipe-line runs in Kentucky in 1910, by districts and months, in barrels.

Month ending—	Cooper.	Elk Spring Valley.	Johnson Fork.	Mount Pisgah.	Parmleysville.	Slickford.	Steubenville.	Total Wayne County.	Barren Creek.
Jan. 22	3,712	1,716	....	....	13,764	3,817	4,435	27,444	1,285
Feb. 26	4,360	1,702	....	....	11,045	3,632	4,369	25,168	744
Mar. 26	4,053	1,939	....	....	10,068	4,545	2,991	23,596	1,092
Apr. 30	5,776	2,524	....	....	17,302	3,880	6,313	35,795	1,087
May 28	3,947	1,554	....	....	13,531	3,180	3,795	26,007	997
June 25	4,205	1,028	345	5,040	7,307	3,357	4,142	25,424	866
July 30	5,801	....	1,521	5,666	12,008	3,595	5,282	33,873	1,032
Aug. 28	3,596	....	1,230	4,019	9,552	2,710	3,005	24,112	640
Sept. 25	3,828	....	1,166	4,627	8,788	2,010	4,013	24,432	660
Oct. 29	4,710	....	518	5,763	10,884	3,067	4,983	29,925	1,178
Nov. 26	3,652	....	1,247	5,203	8,164	2,415	2,813	23,494	997
Dec. 31	4,516	....	1,730	6,525	11,173	2,629	3,564	30,137	784
Total	52,156	10,523	7,757	36,843	133,586	38,837	49,705	329,407	11,362

Pipe-line runs in Kentucky in 1910, by districts and months, in barrels—Continued.

Month ending—	Campton.	Irvine.	Meadow Branch.	Sinking Creek.	Ragland.	Watson.	Williamsburg.	Total.
Jan. 22	4,840	56		595	1,878		325	36,423
Feb. 26	5,750				1,391		216	33,269
Mar. 26	6,349	151					294	31,482
Apr. 30	6,992	229			2,681		215	46,999
May 28	4,989	76			6,625		108	38,802
June 25	5,018				8,310		432	40,050
July 30	4,746	124			5,115		216	45,106
Aug. 28	5,045		255	294	7,700	74	108	38,228
Sept. 25	4,985				2,704		279	33,060
Oct. 29	6,938				3,478		324	41,843
Nov. 26	4,056				2,796		108	31,451
Dec. 31	4,479		394	2,184	1,952	667	216	40,813
Total	64,187	636	649	3,073	44,630	741	2,841	457,526

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 1909 and 1910:

Fluctuations in prices, per barrel, of Kentucky and Tennessee petroleum in 1909 and 1910.

1909. [a]			1910. [a]		
Date.	Somerset (light).	Ragland (heavy).	Date.	Somerset (light).	Ragland (heavy).
Jan. 1	$1.00	$0.65	Jan. 1	$0.72	$0.50
Mar. 25	.90	.60	Jan. 8	.72	.45
May 4	.85	.60			
May 11	.80	.60			
June 26	.75	.55			
July 16	.72	.50			

[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 1906 to 1910, inclusive:

Average monthly prices, per barrel, at wells, of Kentucky and Tennessee petroleum in 1906–1910.[a]

Month.	Somerset (light).					Ragland (heavy).				
	1906	1907	1908	1909	1910	1906	1907	1908	1909	1910
January	$0.89	$0.85	$1.00	$1.00	$0.72	$0.49	$0.59⅜	$0.75	$0.65	$0.46⅛
February	.89	.86¼	1.00	1.00	.72	.49	.60	.75	.65	.45
March	.89	.95½	1.00	.97¾	.72	.49	.61½	.75	.63⅞	.45
April	.89⅜	1.20	1.00	.90	.72	.51⅝	.63⅞	.75	.60	.45
May	.91	1.20	1.00	.81⅞	.72	.62	.70	.75	.60	.45
June	.91	1.20	1.00	.79¼	.72	.62	.75	.72¾	.59¼	.45
July	.90¾	1.20	1.00	.73½	.72	.61¾	.75	.65⅜	.52⅜	.45
August	.86¾	1.20	1.00	.72	.72	.59¼	.75	.65	.50	.45
September	.85	1.20	1.00	.72	.72	.55	.75	.65	.50	.45
October	.85	1.18⅞	1.00	.72	.72	.55	.75	.65	.50	.45
November	.85	1.03½	1.00	.72	.72	.55	.75	.65	.50	.45
December	.85	1.00	1.00	.72	.72	.55	.75	.65	.50	.45
Average	.88	1.09⅛	1.00	.81⅞	.72	.55¼	.70	.69⅞	.56¼	.45⅛

[a] No production recorded in Tennessee.

WELL RECORD.

In the following tables are given the well records for Kentucky and Tennessee from 1906 to 1910, inclusive:

Number of wells completed in Kentucky and Tennessee, 1906–1910, by counties.

County.	Completed.					Dry.					Productive.				
	1906	1907	1908	1909	1910	1906	1907	1908	1909	1910	1906	1907	1908	1909	1910
Bath	.....	4	3	1	.....	.....	4	.....	1	.....	.....	.....	3	.....	.....
Carter	.....	.....	.....	.....	1	.....	.....	.....	.....	1	.....	.....	.....	.....	.....
Cumberland	1	.....	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....
Estill	3	5	.....	.....	.....	.....	1	.....	.....	.....	3	4	.....	.....	.....
Fentress	1	.....	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....
Floyd	.....	.....	1	1	.....	.....	.....	1	1	.....	.....	.....	.....	.....	.....
Johnson	.....	.....	.....	.....	1	.....	.....	.....	.....	1	.....	.....	.....	.....	.....
Lawrence	.....	.....	.....	1	6	.....	.....	.....	1	4	.....	.....	.....	.....	2
Logan	.....	.....	.....	.....	8	.....	.....	.....	.....	1	.....	.....	.....	.....	7
McLean	.....	.....	.....	1	.....	.....	.....	.....	1	.....	.....	.....	.....	.....	.....
Meade	.....	.....	.....	1	1	.....	.....	.....	.....	1	.....	.....	.....	1	.....
Menifee	.....	.....	.....	.....	1	.....	.....	.....	.....	1	.....	.....	.....	.....	.....
Morgan	.....	.....	.....	2	.....	.....	.....	.....	2	.....	.....	.....	.....	.....	.....
Wayne	232	177	175	157	99	70	62	59	71	38	162	115	116	86	61
Wolfe	100	26	21	7	4	12	7	5	2	4	88	19	16	5	.....
Other	.....	1	.....	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....
Total	337	213	200	171	121	84	75	65	79	51	253	138	135	92	70

Number of wells completed in Kentucky and Tennessee, 1906–1910, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
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
1910	4	10	3	11	13	18	17	9	9	11	9	7	121

Number of dry holes drilled in Kentucky and Tennessee, 1906–1910, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
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
1910	3	4	......	4	2	9	10	6	5	5	1	2	51

Total and average initial daily production of new wells in Kentucky and Tennessee, 1906–1910, by counties, in barrels.

County.	Total initial production.					Average initial production per well.				
	1906	1907	1908	1909	1910	1906	1907	1908	1909	1910
Bath and Rowan	......	......	14	......	......	......	......	4.7	......	......
Estill	38	40	......	......	......	12.7	10	......	......	......
Lawrence	......	......	......	......	17	......	......	......	......	8.5
Logan	......	......	......	......	65	......	......	......	......	9.3
Meade	......	......	......	25	......	......	......	......	25.0	......
Wayne	4,569	2,121	2,167	2,111	747	28.2	18.4	18.7	24.5	12.2
Wolfe	1,238	250	261	50	......	14.1	13.2	16.3	10.0	......
	5,845	2,411	2,442	2,186	829	23.1	17.5	18.1	23.8	11.8

Total initial daily production of new wells in Kentucky and Tennessee, 1906–1910, by months, in barrels.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
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
1910	15	110	50	73	149	97	69	60	33	54	81	38	829

WESTERN TENNESSEE.

M. J. Munn, of the United States Geological Survey, has given a valuable report of the oil and gas developments in Tennessee in Bulletin 2–E of the State Geological Survey of Tennessee. Concerning the oil probabilities of western Tennessee. Mr. Munn states that—

There is no way of determining the relative value of the different areas in western Tennessee except by the drill. From the generalized geologic section it will be noted that the Cretaceous rocks lie unconformably upon the eroded surface of the Paleozoic rocks which, to the east, outcrop in the Highlands and Central Basin. Such an arrangement of the strata is favorable for the accumulation of oil and gas in the basal member of the Cretaceous at places where it is an open porous sand lying in contact with the Paleozoic rocks.

The Cretaceous rocks in portions of the Gulf Coastal Plain in Louisiana, Texas, and Mexico have furnished large quantities of oil and gas, where they are not in contact with older oil-bearing rocks, and it is possible that the Cretaceous rocks in Tennessee may be the source of oil and gas. If this is true, the open porous sands of the Ripley and Eutaw formations should furnish excellent reservoirs, and with favorable structural conditions over this region large pools may have accumulated.

Best area for testing.—Though no direct data are available relative to the structure of the Paleozoic rocks of this province, the surface beds are known to dip slightly and uniformly to the west. The general structure of the region, nature of the rocks, position of the unconformity between the Cretaceous and older rocks, and the water conditions in the outcropping bed tend to favor that portion of the province where the Paleozoic floor can be touched at depths of 1,500 feet or more from the surface. If any preference can be made, a belt of territory 15 or 20 miles wide along the western side of the Illinois Central Railroad south from Jackson to the State line may be considered the best area for testing. Any wells sunk for oil or gas in this region should penetrate to the hard Paleozoic rocks, regardless of water conditions in the overlying beds.

OHIO.

Much interest was shown in developing the high-grade oils of Fairfield, Perry, and adjoining counties in southeastern Ohio. The general trend of development was westward. Prospecting was usually for gas, but some extension to the oil pools was also made, so that the limits of the eastern and the western fields are rapidly approaching each other.

Many wells, over 3,000, were abandoned in the sulphur-oil region of northwestern Ohio and in Indiana. Four unusual gushers were drilled in northwestern Ohio. The Sun Oil Co. drilled a 900-barrel well near Tiffin, in Clinton Township, Seneca County. Geyer & Tucker drilled another gusher in the same pool, which began at 250 barrels. A 200-barrel well was drilled in Waterville Township, Lucas County. Finally a 100-barrel well in Washington Township, Auglaize County, caused much additional drilling there, and brought in several other good wells.

The total production showed a decline of 6.74 per cent for the entire State. Detailed statistics are given below.

PRODUCTION.

In the following table is given the production of petroleum in Ohio, by months and districts, for the year 1910:

Production of petroleum in Ohio in 1910, by months and districts, in barrels.

Month.	Lima.	Southeastern Ohio.	Mecca-Belden.	Total.
January	430,261	395,160	....	825,421
February	389,171	355,016	....	744,187
March	488,017	451,068	....	939,085
April	444,837	435,057	....	879,894
May	443,865	454,628	....	898,493
June	436,721	436,580	....	873,301
July	416,649	401,173	....	817,842
August	436,568	411,993	....	848,582
September	407,103	384,210	....	791,313
October	400,640	382,105	....	782,745
November	397,553	353,519	....	751,072
December	402,751	361,684	....	764,435
Total	5,094,136	4,822,193	41	9,916,370

The quantity and value of petroleum produced in Ohio from 1901 to 1910, inclusive, by districts, are shown in the following table:

Quantity and value of petroleum produced in Ohio, 1901–1910, by districts, in barrels.

Year.	Lima.		Southeastern Ohio.		Mecca-Belden.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
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
1910	5,094,136	4,181,629	4,822,193	6,469,314	41	625	9,916,370	10,651,568

WELL RECORD.

In the following tables are given the well records for the southeastern Ohio oil field from 1906 to 1900, inclusive:

Number of wells completed in southeastern Ohio oil field in 1910, by districts and months.

Month.	Alliance.	Barnesville.	Cadiz.	Chester Hill.	Clear Fork.	Corning.	Graysville.	Jackson Ridge.	Jerusalem.	Lewisville.	Macksburg.	Marietta.	Millers Run.	Mingo.	New Castle.	New Matamoras.	Norristown.	Plum Run.	Rinard Mills.	Scio.	Steubenville.	Trailrun.	Woodsfield.	Total.
January	9	...	1	2	...	37	...	1	...	5	6	24	...	3	1	2	...	1	1	2	7	1	2	105
February	5	...	...	4	...	43	1	2	2	4	9	19	...	3	1	3	...	...	...	3	4	...	1	104
March	7	1	1	8	3	40	1	1	...	4	14	27	...	5	4	1	14	...	4	...	3	1	3	142
April	11	1	...	4	2	50	1	2	1	3	16	30	...	3	1	4	7	...	1	...	5	...	1	143
May	11	1	...	8	2	38	2	1	...	5	17	35	...	4	1	1	6	1	...	...	6	2	1	142
June	7	...	1	19	3	44	4	...	4	2	23	35	...	5	1	2	13	1	2	...	6	...	3	175
July	7	1	2	10	...	45	...	...	2	4	13	34	3	...	3	2	10	2	3	...	8	...	1	150
August	4	...	...	11	...	48	1	...	1	4	....	27	1	...	1	4	9	1	4	...	2	...	2	120
September	10	...	1	7	...	36	1	...	3	3	9	21	3	...	1	2	7	1	5	...	9	...	2	121
October	7	...	...	15	...	24	...	...	5	1	5	23	1	...	1	....	2	2	3	...	8	...	1	98
November	8	1	2	11	3	21	...	...	...	...	11	25	...	...	1	....	4	...	2	1	7	...	...	97
December	3	1	...	6	...	28	...	1	1	1	9	21	1	...	1	1	5	2	1	...	8	...	2	92
Total.	89	6	8	105	13	454	11	8	19	36	132	321	9	23	17	22	77	11	26	6	73	4	19	1,489
1909	222	2	28	178	34	598	11	9	35	51	223	406	...	53	11	51	...	18	20	17	168	9	77	[a]2,280

[a] Includes 59 wells in Island Creek.

Number of wells completed in southeastern Ohio oil field, 1906–1910, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
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
1910	105	104	142	143	142	175	150	120	121	98	97	92	1,489

Number of dry holes drilled in southeastern Ohio oil field in 1910, by districts and months.

Month.	Alliance.	Barnesville.	Cadiz.	Chester Hill.	Clear Fork.	Corning.	Graysville.	Jackson Ridge.	Jerusalem.	Lewisville.	Macksburg.	Marietta.	Millers Run.	Mingo.	New Castle.	New Matamoras.	Norristown.	Plum Run.	Rinards Mill.	Scio.	Steubenville.	Trailrun.	Woodsfield.	Total.
January	4	...	1	...	...	11	...	...	...	2	3	10	...	3	...	1	...	...	1	...	5	1	1	43
February	3	...	...	...	...	10	...	...	1	1	4	6	...	2	1	2	...	...	...	1	2	...	...	33
March	5	1	1	3	...	10	1	...	...	2	6	9	...	3	3	1	2	...	2	...	...	...	...	49
April	9	...	...	3	1	20	...	1	...	1	...	10	...	3	...	3	3	...	...	...	3	...	...	57
May	8	...	...	1	...	4	1	...	...	4	6	17	...	4	1	1	2	...	...	...	3	...	1	53
June	3	...	1	6	1	5	4	...	3	2	8	17	...	5	1	2	3	...	2	...	3	...	1	67
July	4	1	2	2	...	14	...	...	1	3	4	12	...	...	2	2	4	...	1	...	2	...	...	54
August	2	...	...	2	...	13	1	...	...	3	...	11	...	...	1	3	6	...	...	...	1	...	1	44
September	5	...	...	3	...	6	...	...	1	3	3	6	...	...	...	1	1	...	2	...	4	...	2	37
October	4	...	...	9	...	7	...	...	2	...	1	10	...	...	1	...	1	1	2	...	4	...	1	43
November	4	1	1	4	...	2	...	...	...	...	3	8	...	...	1	...	...	...	1	...	3	...	...	28
December	1	1	...	2	...	8	...	...	1	...	3	9	...	...	...	...	2	...	...	...	6	...	1	34
Total.	52	4	6	35	2	110	7	1	9	21	41	125	...	20	11	16	24	1	11	1	36	1	8	[a] 542
1909	92	1	10	61	9	187	6	3	23	15	65	145	...	37	3	20	...	9	14	11	50	4	26	[b] 820

[a] Includes 76 wells which produce gas. [b] Includes 29 wells in Island Creek.

Number of dry holes drilled in southeastern Ohio oil field, 1906–1910, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1906	32	51	53	46	47	68	54	67	49	57	45	61	630
1907	35	26	31	34	47	51	60	51	52	53	45	36	521
1908	25	33	30	32	44	50	49	45	67	55	59	82	571
1909	57	54	64	67	53	72	91	90	82	53	78	59	820
1910	43	33	49	57	53	67	54	44	37	43	28	34	[a] 542

[a] Includes 76 gas wells.

Initial daily production of new wells completed in southeastern Ohio oil field in 1910, by districts and months, in barrels.

Month.	Alliance.	Barnesville.	Cadiz.	Chester Hill.	Clear Fork.	Corning.	Graysville.	Jackson Ridge.	Jerusalem.	Lewisville.	Macksburg.	Marietta.	Millers Run.
January	87	...	...	10	...	1,069	...	10	...	28	10	65	...
February	32	...	...	9	...	1,182	5	7	5	43	16	80	...
March	42	...	...	40	10	1,850	...	20	...	32	95	182	...
April	55	3	...	2	5	2,175	20	5	5	101	77	208	...
May	21	5	...	35	6	1,762	5	5	...	10	51	368	...
June	12	...	...	60	12	1,565	...	...	15	...	103	230	...
July	18	...	...	63	...	890	...	...	90	3	27	118	14
August	5	...	...	99	...	499	...	...	65	5	...	124	5
September	15	...	8	70	...	744	3	...	55	...	12	56	20
October	6	...	...	83	...	672	...	...	230	5	10	86	5
November	11	...	5	61	8	472	...	...	...	...	21	160	...
December	2	...	...	19	...	444	...	5	...	5	34	90	5
Total.	306	8	13	551	41	13,324	33	52	465	232	456	1,767	49
1909	2,936	2	101	363	124	8,113	21	80	127	500	1,230	3,470	...

Initial daily production of new wells completed in southeastern Ohio oil field in 1910, by districts and months, in barrels—Continued.

Month.	Mingo.	New Castle.	New Matamoras.	Norristown.	Plum Run.	Rinard Mills.	Scio.	Steubenville.	Trailrun.	Woodsfield.	Total.
January	....	2	5	....	3	......	7	15	......	8	1,319
February	1	....	20	....	......	......	20	10	......	10	1,440
March	6	3	....	83	......	2	......	9	2	12	2,388
April	....	3	40	30	......	3	......	10	......	5	2,747
May	....	....	....	22	2	......	......	12	10	....	2,314
June	....	....	....	38	2	......	......	17	......	11	2,065
July	....	5	....	23	10	6	......	24	......	5	1,296
August	....	....	5	26	5	28	......	2	......	4	872
September	....	4	4	22	5	9	......	18	......	....	1,045
October	....	....	....	20	3	1	......	14	......	....	1,135
November	....	....	....	18	......	5	4	10	......	....	775
December	....	3	2	20	4	2	......	5	......	2	642
Total	7	20	76	302	34	56	31	146	12	57	18,038
1909	745	185	418	....	61	40	18	4,135	23	2,086	[a] 26,152

[a] Includes 1,374 barrels produced in Island Creek.

Total initial daily production of new wells in southeastern Ohio oil field, 1906–1910, by months, in barrels.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.	Average.
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
1910	1,319	1,440	2,388	2,747	2,314	2,065	1,296	872	1,045	1,135	775	642	18,038	1,503

Number of wells completed in central Ohio oil field September–December, 1910, by counties.

County.	Completed.					Oil.					Gas.					Dry.				
	September.	October.	November.	December.	Total.	September.	October.	November.	December.	Total.	September.	October.	November.	December.	Total.	September.	October.	November.	December.	Total.
Ashland	....	....	....	2	2	....	....	....	....	....	....	....	....	2	2	....	....	....	....	....
Athens	....	....	1	....	1	....	....	1	....	1	....	....	....	....	....	....	....	....	....	....
Champaign	1	....	....	....	1	....	....	....	....	....	1	....	....	....	1	....	....	....	....	....
Fairfield	4	3	4	10	21	....	....	....	....	....	4	3	3	8	18	....	....	1	2	3
Hardin	1	....	....	....	1	....	....	....	....	....	1	....	....	....	1	....	....	....	....	....
Hocking	....	....	4	6	10	....	....	....	....	....	....	....	4	5	9	....	....	....	1	1
Knox	3	....	3	7	13	....	....	....	....	....	2	....	3	7	12	1	....	....	....	1
Licking	24	17	18	31	90	1	1	....	....	2	21	15	14	27	77	2	1	4	4	11
Lorain	1	....	....	....	1	....	....	....	....	....	1	....	....	....	1	....	....	....	....	....
Medina	....	1	....	....	1	....	1	....	....	1	....	....	....	....	....	....	....	....	....	....
Muskingum	....	1	....	1	2	....	1	....	....	1	....	....	....	....	....	....	....	....	1	1
Perry	....	....	1	4	5	....	....	....	....	....	....	....	....	4	4	....	....	1	....	1
Vinton	....	....	1	....	1	....	....	1	....	1	....	....	....	....	....	....	....	....	....	....
Wayne	....	....	1	....	1	....	....	....	....	....	....	....	1	....	1	....	....	....	....	....
Total	34	22	33	61	150	1	3	2	....	6	30	18	25	53	126	3	1	6	8	18

Total and average initial daily production of new wells in central Ohio oil field September–December, 1910, by counties, in barrels.

County.	Total initial production.					Average initial production per well.				
	Sept.	Oct.	Nov.	Dec.	Total.	Sept.	Oct.	Nov.	Dec.	Total.
Athens			3		3			3		3
Licking	10	40			50	10	40			25
Medina		10			10		10			10
Muskingum		10			10		10			10
Vinton			5		5			5		5
Total	10	60	8		78	10	20	4		13

LIMA-INDIANA OIL FIELD.

PRODUCTION.

In the following table will be found the production of the Lima-Indiana field, by States and months, for the year 1910:

Production of petroleum in the Lima-Indiana field in 1910, by months, in barrels.

Month.	Lima, Ohio.	Indiana.	Total.
January	430,261	143,481	573,742
February	389,171	136,388	525,559
March	488,017	163,588	651,605
April	444,837	161,865	606,702
May	443,865	178,582	622,447
June	436,721	292,521	729,242
July	416,649	219,210	635,859
August	436,568	200,681	637,249
September	407,103	179,536	586,639
October	400,640	169,338	569,978
November	397,553	159,878	557,431
December	402,751	154,657	557,408
Total	5,094,136	2,159,725	7,253,861

In the following table will be found the production of the Lima-Indiana field from 1901 to 1910, 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, 1901–1910.

Year.	Production, in barrels.	Percentage of total production.	Increase.	Decrease.	Percentage.	
					Increase.	Decrease.
1901	21,933,379	3[illegible].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	4.48		1,820,862		18.15
1910	7,253,861	3.46		957,582		11.66

Production and value of petroleum in the Lima-Indiana field, 1906–1910, in barrels.

Year.	North Lima, Ohio.		South Lima, Ohio.		Indiana.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
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
1910	4,131,060	3,431,618	963,076	750,011	2,159,725	1,568,475	7,253,861	5,750,104

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 1910:

Pipe-line runs in the Lima-Indiana oil field in 1910, by months, in barrels.

Month.	Buckeye pipe line.	Other Ohio.	Indiana pipe line.	Other Indiana.	Total.
January	296,799	133,462	112,751	30,730	573,742
February	266,397	122,774	108,482	27,906	525,559
March	342,409	145,608	139,390	24,198	651,605
April	305,691	139,146	126,808	35,057	606,702
May	331,450	112,415	142,023	36,559	622,447
June	327,399	109,322	144,489	148,032	729,242
July	310,653	105,996	126,782	92,428	635,859
August	322,882	113,686	132,229	68,452	637,249
September	304,365	102,738	117,737	61,799	586,639
October	297,947	102,693	113,366	55,972	569,978
November	295,873	101,680	100,007	59,871	557,431
December	302,626	100,125	104,748	49,909	557,408
Total	3,704,491	1,389,645	1,468,812	690,913	7,253,861

Pipe-line deliveries of petroleum in the Lima-Indiana oil field in 1910, by months, in barrels.

Month.	Buckeye pipe line.	Indiana pipe line.	Other.[a]	Total.
January	265,647	830,130	135,190	1,230,967
February	229,256	712,424	135,190	1,076,870
March	351,584	790,050	135,190	1,276,824
April	403,710	781,824	135,190	1,320,724
May	340,351	867,410	135,190	1,342,951
June	312,511	993,871	135,190	1,441,572
July	311,723	979,193	135,191	1,426,107
August	292,891	774,558	135,191	1,202,640
September	323,120	756,755	135,190	1,215,065
October	369,762	1,001,133	135,190	1,506,085
November	322,501	994,733	135,190	1,452,424
December	299,305	1,050,412	135,190	1,484,907
Total	3,822,361	10,532,493	1,622,282	15,977,136

a Averaged.

Gross stocks of crude petroleum in the Lima-Indiana oil field in 1910, by months, in barrels.

Month.	Buckeye pipe line.	Indiana pipe line.	Other.	Total.
January	4,906,626	1,008,104		
February	4,563,889	1,052,193		
March	4,937,403	1,080,830		
April	5,353,398	1,005,182		
May	5,607,671	1,023,323		
June	5,359,336	1,183,811		
July	5,433,288	1,109,786		
August	5,354,047	1,022,705		
September	5,457,941	1,021,189		
October	5,268,330	935,154		
November	5,082,581	976,061		
December	5,137,403	961,010	480,659	6,579,072

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 1909 and 1910. The dates are those on which changes in prices were made.

Fluctuations in prices of Lima (Ohio) and Indiana petroleum in 1909 and 1910, per barrel.

Date.	1909			Date.	1910		
	North Lima.	South Lima and Indiana.	Princeton, Ind.		North Lima.	South Lima and Indiana.	Princeton, Ind.
Jan. 1	$1.04	$0.99	$0.68	Jan. 1	$0.84	$0.79	$0.60
May 4	.99	.94	.68	June 11	.82	.77	.60
May 11	.94	.89	.68				
June 26	.89	.84	.65				
July 16	.86	.81	.62				
Oct. 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 1908 to 1910:

Average monthly prices of Ohio and Indiana petroleum in 1908, 1909, and 1910, per barrel.

Month.	1908			1909			1910		
	North Lima.	South Lima and Indiana.	Princeton, Ind.	North Lima.	South Lima and Indiana.	Princeton, Ind.	North Lima.	South Lima and Indiana.	Princeton, Ind.
January	$0.94	$0.89	$0.68	$1.04	$0.99	$0.68	$0.84	$0.79	$0.60
February	.97¾	.92¾	.68	1.04	.99	.68	.84	.79	.60
March	1.04	.99	.68	1.04	.99	.68	.84	.79	.60
April	1.04	.99	.68	1.04	.99	.68	.84	.79	.60
May	1.04	.99	.68	.96	.91	.68	.84	.79	.60
June	1.04	.99	.68	.93¼	.88¼	.67½	.82¾	.77¾	.60
July	1.04	.99	.68	.87⅜	.82⅜	.63⅜	.82	.77	.60
August	1.04	.99	.68	.86	.81	.62	.82	.77	.60
September	1.04	.99	.68	.86	.81	.62	.82	.77	.60
October	1.04	.99	.68	.85¼	.80¼	.61¼	.82	.77	.60
November	1.04	.99	.68	.84	.79	.60	.82	.77	.60
December	1.04	.99	.68	.84	.79	.60	.82	.77	.60
Average	1.02⅝	.97⅝	.68	.93⅛	.88⅛	.64⅝	.82⅞	.77⅞	.60
Average of North Lima, South Lima, and Indiana	1.00⅛			.90⅝			.80⅜		

In the following table will be found the highest, lowest, and average prices of Lima (Ohio) oil for the last 10 years:

Highest, lowest, and average prices of Lima (Ohio) petroleum, 1901–1910, per barrel.

Year.	Highest.	Lowest.	Average.	Year.	Highest.	Lowest.	Average
1901	a $0.94	b $0.74	$0.86	1906	a $0.98	b $0.85	0.91\frac{1}{8}$
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$\frac{3}{8}$	1909	a 1.04	b .79	.90$\frac{5}{8}$
1905	a 1.01	b .81	.88$\frac{3}{4}$	1910	a .84	b .77	.80$\frac{3}{8}$

a North Lima. b South Lima.

WELL RECORD.

In the following tables are given the well records for the Lima (Ohio) oil field from 1906 to 1910, inclusive:

Number of wells completed in the Lima (Ohio) district, 1906–1910, by counties.

County.	Completed.					Dry.					Productive.				
	1906	1907	1908	1909	1910	1906	1907	1908	1909	1910	1906	1907	1908	1909	1910
Allen	115	34	61	79	13	10	4	1	4	1	105	30	60	75	12
Auglaize	23	8	8	15	22	6	3	.....	4	5	17	5	8	11	17
Hancock	161	121	92	111	125	17	20	9	5	11	144	101	83	106	114
Hardin	.....	.....	.....	.....	5	.....	.....	.....	.....	3	.....	.....	.....	.....	2
Henry	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....
Lucas	59	40	34	21	7	6	3	4	.....	.....	53	37	30	21	7
Mercer	74	21	8	6	5	5	2	1	1	1	69	19	7	5	4
Ottawa	100	57	44	57	25	19	4	2	4	2	81	53	42	53	23
Putnam	.....	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
Sandusky	290	212	162	116	71	13	24	12	9	7	277	188	150	107	64
Seneca	93	41	81	83	54	6	6	21	12	7	87	35	60	71	47
Van Wert	67	42	108	83	20	11	11	4	8	2	56	31	104	75	18
Wood	471	258	229	282	217	36	28	17	29	28	435	230	212	253	189
Wyandot	61	60	19	9	5	8	22	7	.....	2	53	38	12	9	3
Miscellaneous	35	12	2	a 9	2	25	9	2	a 9	2	10	3	.....	.....	.....
Total	1,549	906	848	872	572	162	136	80	85	b 71	1,387	770	768	787	501

a Includes 8 gas wells. b Includes 13 gas wells.

Number of wells completed in the Lima (Ohio) district, 1906–1910, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
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
1910	29	27	31	46	55	57	59	56	54	44	69	45	572

Number of dry holes drilled in the Lima (Ohio) district, 1906–1910, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
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
1910	5	3	5	6	9	7	7	5	6	6	6	6	a 71

a Includes 13 gas wells.

Total and average initial daily production of new wells in the Lima (Ohio) district, 1906–1910, by counties, in barrels.

County.	Total initial production.					Average initial production per well.				
	1906	1907	1908	1909	1910	1906	1907	1908	1909	1910
Allen	1,098	284	694	708	110	10.5	9.5	11.6	9.4	9.2
Auglaize	85	22	75	138	306	5.0	4.4	9.4	12.5	18.0
Hancock	1,687	1,090	1,042	1,253	1,505	11.7	10.8	12.6	11.8	13.2
Hardin	......	......	......	......	13	......	......	......	......	6.5
Henry	......	......	......	5	......	......	......	......	5.0	......
Lucas	567	433	327	203	116	10.7	11.7	10.9	9.7	16.6
Mercer	1,026	220	55	35	65	14.9	11.6	7.9	7.0	16.3
Ottawa	663	479	336	450	183	8.2	9.0	8.0	8.5	8.0
Putnam	......	......	......	......	3	......	......	......	......	3.0
Sandusky	1,672	1,061	822	561	422	6.0	5.6	5.5	5.2	6.6
Seneca	410	664	800	582	737	4.7	19.0	13.3	8.2	15.7
Van Wert	746	361	1,268	639	192	13.3	11.6	12.2	8.5	10.7
Wood	4,621	2,128	3,067	3,423	3,003	10.6	9.2	14.5	13.5	15.9
Wyandot	1,758	1,087	235	121	90	33.2	28.6	19.6	13.4	30.0
Miscellaneous	158	23	......	......	......	15.8	7.7	......	......	......
Total	14,491	7,852	8,721	8,118	6,745	10.4	10.2	11.4	10.3	13.5

Total initial daily production of new wells in the Lima (Ohio) district, 1906–1910, by months, in barrels.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
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
1910	377	425	500	530	565	447	684	735	794	441	723	524	6,745

INDIANA.

PRODUCTION.

The decline in the old pools of the northern part of Indiana was somewhat offset by the interesting developments in the southwest, especially the Oakland City pool in Pike County. The total for the State was 2,159,725 barrels, as compared with 2,296,086 barrels in 1909, a decline of only 5.94 per cent.

In the following table are shown the output and value of petroleum produced in the State of Indiana during the years 1901–1910:

Production and value of petroleum in Indiana, 1901–1910, in barrels.

Year.	Quantity.	Value.	Price per barrel.
1901	5,757,086	$4,822,826	$0.84
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
1910	2,159,725	1,568,475	.73

Production of petroleum in Indiana, 1906-1910, by months, in barrels.

Month.	1906	1907	1908	1909	1910
January	742,478	483,994	323,620	202,055	143,481
February	638,211	451,111	262,189	182,914	136,388
March	675,066	458,119	296,478	221,455	163,588
April	666,213	468,057	302,416	211,265	161,865
May	684,618	481,895	302,290	212,575	178,582
June	664,031	438,428	292,156	211,981	292,521
July	654,349	461,912	289,040	205,182	219,210
August	683,458	427,877	269,667	198,306	200,681
September	572,489	380,269	259,162	184,207	179,536
October	616,556	386,568	241,468	172,505	169,338
November	555,639	349,238	219,348	170,871	159,878
December	520,369	340,569	225,795	122,770	154,657
Total	7,673,477	5,128,037	3,283,629	2,296,086	2,159,725

WELL RECORD.

In the following table is given the well record for Indiana from 1906 to 1910, inclusive:

Number of wells completed in Indiana, 1906-1910, by counties.

County.	Completed.					Dry.					Productive.				
	1906	1907	1908	1909	1910	1906	1907	1908	1909	1910	1906	1907	1908	1909	1910
Adams	48	32	15	14	13	4	3	2	3	1	44	29	13	11	12
Blackford	64	22	40	23	9	9	3	9	4	3	55	19	31	19	6
Cass				3					2					1	
Daviess				1	1									1	1
Delaware	180	65	29	13	10	39	16	14	5	1	141	49	15	8	9
Dubois					5					4					1
Gibson	48	21	10	8	9	8	4	3	6	7	40	17	7	2	2
Grant	236	115	90	37	2	20	12	7	2	1	216	103	83	35	1
Huntington	123	48	17	15	3	2	2	2	3		121	46	15	12	3
Jay	205	152	107	63	34	27	30	25	17	13	178	122	82	46	21
Knox					4					3					1
Madison	3	5	2	1		1	2				2	3	2	1	
Martin					2					1					1
Miami				1					1						
Pike				65	215				27	36				38	179
Pulaski				4					3					1	
Randolph	26	3	5	5	20	8	1	1	1	7	18	2	4	4	13
Sullivan					3										3
Vigo				2	1				1	1				1	
Warrick					3					3					
Wells	235	122	70	39	31	11	2	4			224	120	66	39	31
Miscellaneous	26	73	17	11	1	11	53	15	11	1	15	20	2		
Total	1,194	658	402	305	366	140	128	82	86	a 82	1,054	530	320	219	284

a Includes 16 gas wells.

Number of wells completed in Indiana, 1906-1910, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
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
1910	18	33	29	27	25	38	38	41	35	26	36	20	366

Number of dry holes drilled in Indiana, 1906-1910, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
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
1910	9	6	3	6	5	4	4	9	7	5	17	7	a 82

a Includes 16 gas wells.

Total and average initial daily production of new wells in Indiana, 1906–1910, by counties, in barrels.

County.	Total initial production.					Average initial production per well.				
	1906	1907	1908	1909	1910	1906	1907	1908	1909	1910
Adams	441	171	177	58	73	10.0	5.9	13.6	5.3	6.1
Blackford	695	140	264	140	75	12.6	7.4	8.5	7.4	12.5
Cass				2					2.0	
Daviess				20	5				20.0	5.0
Delaware	4,774	715	312	142	232	33.8	14.6	20.8	17.8	25.8
Dubois					15					15.0
Gibson	795	304	75	35	20	19.9	17.9	10.7	17.5	10.0
Grant	1,742	770	749	167	1	8.1	7.5	9.0	4.8	1.0
Huntington	1,650	485	154	77	40	13.6	10.5	10.3	6.4	13.3
Jay	2,742	1,362	900	378	203	15.4	11.2	11.0	8.2	9.7
Knox					10					10.0
Madison	30	50	15	40		15.0	16.7	7.5	40.0	
Martin					5					5.0
Miami										
Pike				2,385	7,453				62.7	41.6
Pulaski				5					5.0	
Randolph	608	25	35	130	207	33.8	12.5	8.8	32.5	15.9
Sullivan					25					8.3
Vigo				20					20.0	
Warrick										
Wells	2,109	1,067	537	264	300	9.4	8.9	8.1	6.8	9.7
Miscellaneous	253	308	40			16.9	15.4	20.0		
Total	15,839	5,397	3,258	3,863	8,664	15.0	10.2	10.2	17.6	30.5

Total initial daily production of new wells in Indiana, 1906–1910, by months, in barrels.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
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
1910	488	885	820	714	746	1,745	676	1,159	400	480	290	261	8,664

In the following tables are given the number of oil wells abandoned in the Lima-Indiana oil field from June, 1905, to December 31, 1910, inclusive:

Number of oil wells abandoned in the Indiana oil fields and in Lima (Ohio) oil field from June, 1905, to December, 1910, by months.

Month.	1905	1906	1907	1908	1909	1910	Total.
January		54	45	75	149	61	384
February		74	83	59	108	66	390
March		27	49	129	237	221	663
April		47	129	198	98	140	612
May		100	194	358	204	157	1,013
June	28	82	143	207	347	146	953
July	53	50	111	191	157	176	738
August	54	147	170	228	322	126	1,047
September	19	87	157	195	267	294	1,019
October	158	139	181	144	201	80	903
November	53	139	177	155	172	100	796
December	66	117	62	220	156	128	749
Total, Indiana	431	1,063	1,501	2,159	2,418	1,695	9,267
Total, Lima, Ohio	674	1,059	1,357	1,135	1,127	1,500	6,852
Total, Lima-Indiana	1,105	2,122	2,858	3,294	3 545	3,195	16,119

Number of oil wells abandoned in the Lima-Indiana oil field June, 1905, to Dec. 31, 1910, by counties.

Lima, Ohio.		Indiana.	
County.	Number of wells.	County.	Number of wells.
Allen	1,392	Adams	562
Auglaize	647	Blackford	1,063
Darke	4	Delaware	1,037
Hancock	857	Gibson	1
Lucas	294	Grant	2,832
Mercer	217	Hamilton	4
Ottawa	83	Huntington	579
Putnam	17	Jay	348
Sandusky	536	Madison	87
Seneca	87	Marion	15
Shelby	4	Miami	49
Van Wert	473	Randolph	191
Wood	2,082	Wabash	16
Wyandot	159	Wells	2,483
Total	6,852	Total	9,267

ILLINOIS OIL FIELD.

PRODUCTION AND DEVELOPMENT.

In reviewing the larger oil fields from the east westward the condition of declining production ceases when Illinois is reached. A total of 33,143,362 barrels produced in 1910 is almost the record output for the State and exceeds the total for 1909 by 2,244,023 barrels, or 7.27 per cent. In 1908 the product was 33,686,238 barrels. The increase in 1910 was due largely to the active drilling in the deep territory of Lawrence County, where two new sands, the "Tracy" and the "McClosky," were found beneath those previously known; but an equally interesting feature was the development of the Centralia-Sandoval pool in Marion County. Careful and thorough work of R. S. Blatchley enabled the Illinois State Geological Survey to indicate regions of probable petroleum pools and the actual and successful development followed in 1911, especially at Carlyle, in Clinton County. The credit for developing this Clinton County field belongs to the Illinois State Geological Survey, which, from structural considerations, pointed out this as a probable locality for an oil pool.

The following details of the developments in the Illinois field in 1910 are taken from a circular of the Illinois State Geological Survey by Raymond S. Blatchley, geologist:[1]

THE SOUTHEASTERN ILLINOIS FIELDS.

Clark County.—The Clark County and adjoining shallow oil areas were almost inactive, and little drilling was done during the year. One profitable deep test was drilled to a depth of 2,969 feet by the Ohio Oil Co. on the K. and N. E. Young farm, near Casey. Oil and gas of considerable sulphur content were found at 2,750 feet, seemingly in the "Trenton" limestone. The combined daily output of the Clark, Cumberland, and Edgar County wells was about 9,000 barrels.

Crawford County.—Considerable drilling in Crawford County failed to prevent the decline of new production over 1909. The drilling was chiefly scattered over the entire pool during the greater part of the year. In the later months a concentration of

[1] The Illinois oil field in 1910.

development took place in the Bellair (Licking Township) area, where new productive sands between 1,000 and 1,100 feet were found. Many good wells were completed. The average well in the county is far below the previous initial yield, indicating the inevitable decline unless new sands are discovered. The yield reached about 30,000 barrels daily in 1910 as against 100,000 in 1907.

Lawrence County.—Highly profitable but expensive drilling took place in Lawrence County, where seven distinct sands produce oil in varying quantity and grade. They lie between 750 and 1,900 feet in depth, and in order are: The Bridgeport No. 1 and No. 2 sands, from 750 to 900 feet deep; the Buchanan sand, 1,275 to 1,400 feet; the Kirkwood sand, 1,550 to 1,650 feet; the Tracy sand, 1,700 to 1,750 feet; the McClosky sand, 1,825 to 1,860 feet, and the Green, Henry, and Pepple sands, from 1,850 to 1,900 feet deep, possessing a few wells each and very narrow limits. The McCloskey and Tracy sands are the richest developed in Illinois. The former is in the "King-Applegate pool." The chief activities of the year were in the two above-mentioned sands. Most of all the wells from these sands produced, initially, between 500 and 2,000 barrels. A short-lived impetus was given to the Lawrence County area early in the year, when a new pool was tapped on the outskirts of Lawrenceville, some 2 miles or more from the active fields. Two wells of 100-barrels yield were drilled, but several surrounding dry wells discredited the area. The average daily yield of the Lawrence County area was between 45,000 and 55,000 barrels. Both "sour" and "sweet" oils were produced, but each was handled separately.

Surrounding areas.—Considerable wildcatting was done several miles west and south of the present fields in Richland, Clay, Wayne, Gallatin, and Wabash counties, but without any showing of oil except in Gallatin County, where the amounts were small and insignificant. The area in Richland, Wayne, and Clay counties lies on or near the synclinal axis of the Illinois coal basin.

SOUTHERN CENTRAL AND WESTERN ILLINOIS.

Marion County.—The best results from recent wildcatting were obtained in Marion County during 1909–10. The new Sandoval field of 4 wells in 1909, now, on December 1, 1910, has 35 producing wells yielding over 3,000 barrels daily, 16 dry holes, and 22 drilling wells. The oil comes from the Benoist sand, in the Chester formations of the Mississippian series of rocks, and is equivalent to the Kirkwood sand of Lawrence County. Its average depth is about 1,550 feet. A second pool was opened up during the year near Centralia, several miles south of the Sandoval area. Four light wells and several dry holes have been drilled. The productive sand is the same as that found near Sandoval. The two fields seem to lie along an irregular terrace upon the broad and gentle western flank of the Illinois basin. The general trend is to Duquoin, on the south, and to Brownstown and Pana, to the north. Much drilling is contemplated along this area.

Bond County.—A new gas area was tapped early in the year near Greenville. The sand was found between 950 and 1,000 feet and was correlated with the Benoist sand of Sandoval and the Kirkwood sand of Lawrence County. The wells yielded from 1,250,000 to 2,000,000 cubic feet of gas daily. A recent test was put down on the Brown farm, near Pocahontas, and secured an initial production of about 25 barrels at a depth of 1,975 feet. The pay seems to lie in the Niagara limestone. Much drilling is being done at the present time in an effort to develop both the gas and the lower oil pay.

WILDCAT WORK IN WESTERN ILLINOIS.

Several light-pressure gas wells were drilled near Jacksonville, Morgan County, during the year. The yield came from a depth of about 300 feet and was odorless and colorless, but burned with a very hot blue flame. Several barren wells were drilled in Jefferson, Washington, Perry, Monroe, and Clinton counties. Much new drilling was started late in the year along the Sandoval-Duquoin terrace, especially in Washington and Perry counties.

On January 1, 1910, it was estimated that 16,497 wells had been drilled in Illinois. Of these, 2,379, or 14.4 per cent, were barren. In the first 11 months of 1910, 1,973 wells were drilled, with 430, or 21.8 per cent, barren. The total up to date is 18,470 drilled and 2,809, or 15.6 per cent, barren.

The total production, by months, for the last six years is given in the following table:

Production of petroleum in Illinois, 1905–1910, by months, in barrels.

Month.	1905	1906	1907	1908	1909	1910
January	....	55,680	781,812	2,703,973	2,668,607	2.640,303
February	....	65,208	956,399	2,572,115	2,510,548	2,353,684
March	....	19,352	1,547,323	2,825,491	2,757,794	2,865,055
April	....	102,862	1,874,465	3,249,690	2,562,215	2,776,800
May	....	267,746	2,138,918	3,223,515	2,829,277	2,860,760
June	6,521	410,655	1,879,362	3,081,848	2,670,549	2,746,620
July	17,306	610,401	2,422,192	2,693,288	2,728,857	3,029,787
August	23,827	778,464	2,446,042	2,808,667	2,719,958	3,007,151
September	26,586	722,168	2,605,663	2,675,385	1,902,197	2,850,119
October	27,589	463,819	2,863,812	2,709,913	2,560,072	2,768,750
November	34,611	350,985	2,510,146	2,479,926	2,497,847	2,629,132
December	44,644	549,710	2,255,839	2,662,427	2,490,418	2,615,201
Total	181,084	4,397,050	24,281,973	33,686,238	30,898,339	33,143,362

Production and value of petroleum in Illinois, 1905–1910, 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
1910	27,751,090	5,392,272	33,143,362	19,669,383

Production of petroleum in Illinois in 1909 and 1910, by kinds, in barrels.

Year.	Light.	Heavy.	Total.
1909	28,049,468	2,848,871	30,898,339
1910	30,444,279	2,699,083	33,143,362

PIPE-LINE RUNS, DELIVERIES, AND STOCKS.

The following tables show the runs of the Ohio Oil Co. during the years 1905–1910, and deliveries and stocks in 1907–1910, by months:

Pipe-line runs, deliveries, and stocks of the Ohio Oil Co. in Illinois, 1905–1910, by months, in barrels.

Month.	Pipe-line runs.					
	1905	1906	1907	1908	1909	1910
January	....	55,680	752,671	2,497,359	2,494,492	2,220,842
February	....	65,208	918,620	2,464,914	2,358,198	1,976,637
March	....	19,352	1,494,598	2,591,911	2,568,392	2,377,012
April	....	102,862	1,823,025	3,089,417	2,388,309	2,306,336
May	....	267,746	2,094,195	3,084,816	2,536,413	2,374,134
June	5,489	410,655	1,830,634	2,965,786	2,365,956	2,274,501
July	9,208	610,401	2,376,281	2,579,977	2,413,218	2,569,830
August	15,092	778,464	2,398,895	2,690,931	2,411,483	2,528,532
September	19,592	722,168	2,560,593	2.555,871	1,595,934	2,409,232
October	26,444	463,819	2,818,032	2,582,561	2,228,269	2,334,659
November	34,766	350,985	2,464,981	2,356,386	2.149,372	2,211,286
December	45,912	538,131	2,201,265	2,512,705	2,130,737	2,168,089
Total	156,503	4,385,471	23,733,790	31,972,634	27,640,773	27,751,090

Pipe-line runs, deliveries, and stocks of the Ohio Oil Co. in Illinois, 1905–1910, by months, in barrels—Continued.

Month.	Deliveries.			
	1907	1908	1909	1910
January	142,001	1,720,631	324,887	1,226,379
February	401,344	1,882,978	869,212	842,135
March	444,078	1,010,459	721,519	882,209
April	385,432	1,476,192	891,423	936,706
May	563,585	1,869,461	903,838	946,346
June	551,502	1,846,947	1,077,383	1,156,895
July	1,395,238	2,012,288	1,176,410	1,332,242
August	1,440,640	1,774,354	1,052,431	1,229,479
September	1,105,589	1,488,283	849,533	1,135,323
October	1,590,566	1,394,983	938,860	1,245,778
November	1,815,964	1,284,304	1,120,751	997,805
December	848,450	1,789,158	685,585	1,036,260
Total	10,684,389	19,550,038	10,611,832	12,967,557

Month.	Stocks.			
	1907	1908	1909	1910 [a]
January	2,509,598	14,129,954	25,876,529	28,355,182
February	3,040,111	15,069,278	26,203,238	28,356,243
March	4,117,635	15,975,633	26,630,509	28,373,855
April	5,528,759	17,420,534	26,856,675	28,593,365
May	7,117,033	19,077,020	27,593,494	29,025,647
June	8,448,344	20,456,387	27,899,220	29,106,098
July	9,387,999	21,036,143	27,627,086	29,198,965
August	10,355,000	22,267,197	27,683,334	29,177,382
September	12,557,522	23,485,690	28,399,427	28,879,676
October	13,724,691	24,396,787	28,535,636	28,492,136
November	14,275,036	24,905,168	28,373,985	28,086,619
December	15,751,305	25,252,468	28,671,543	27,348,358

[a] Includes some Indiana petroleum.

The following table shows the quantity of petroleum shipped by railroad from the Illinois oil field, 1907 to 1910, by months:

Shipments of petroleum by railroad in tank cars from Illinois oil field, in pounds and equivalent in barrels, 1907–1910, by months.

Month.	1907 [a]		1908 [b]		1909 [c]		1910 [d]	
	Pounds.	Barrels.	Pounds.	Barrels.	Pounds.	Barrels.	Pounds.	Barrels.
January	2,607,940	8,701	27,369,575	91,807	42,962,321	144,511	65,642,102	220,856
February	4,361,996	14,598	21,191,859	71,170	33,135,044	111,407	64,727,081	217,917
March	7,158,170	23,947	39,352,395	132,300	45,220,034	152,056	78,297,914	263,056
April	12,609,699	42,249	35,198,236	118,074	32,756,603	109,872	76,629,857	257,292
May	47,076,459	158,227	25,177,339	84,290	46,914,958	157,783	84,174,328	283,285
June	49,701,853	166,644	36,566,990	122,317	54,585,149	183,432	84,794,030	285,095
July	96,137,954	322,622	32,087,310	107,688	47,158,942	158,642	82,242,109	276,533
August	66,661,072	223,134	20,912,433	70,171	49,602,064	166,943	82,505,800	277,317
September	21,203,105	70,555	24,771,903	83,042	51,574,673	173,509	75,462,070	253,788
October	17,055,726	56,570	30,427,564	102,163	59,425,540	200,067	63,301,200	213,217
November	16,831,726	56,080	41,096,712	138,147	58,881,214	198,044	85,453,500	287,750
December	19,952,993	66,692	37,751,352	126,967	55,130,392	185,166	69,768,400	234,819
Total	361,358,693	[e] 1,210,019	371,903,668	[e] 1,248,136	577,346,934	[e] 1,941,432	912,998,391	[e] 3,070,925

[a] 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.

[b] 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.

[c] 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.

[d] Shipments were made from Duncansville, Flat Rock, Lawrenceville, Stoy, Sandoval, Bridgeport, Casey, and Sparta, the same railroads shipping in 1910 as in 1908 and 1909. The number of tank cars shipped in 1910 was 17,049.

[e] Calculations made according to specific gravity of the oil, ranging from 296.476 to 321.17 pounds to the barrel.

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, 1909, and 1910:

Fluctuation in prices, per barrel, of Illinois petroleum in 1908, 1909, and 1910.

1908			1909			1910		
Date.	Above 30° B.	Below 30° B.	Date.	Above 30° B.	Below 30° B.	Date.	Above 30° B.	Below 30° B.
Jan. 1	$0.68	$0.60	Jan. 1	$0.68	$0.60	Jan. 1	$0.60	$0.52
			June 26	.65	.57			
			July 16	.62	.54			
			Oct. 21	.60	.52			

In the following table are given the average monthly prices paid for Illinois petroleum at wells in Illinois from 1905 to 1910, inclusive:

Average monthly prices of Illinois petroleum, 1905–1910, per barrel.

Month.	1905	1906	1907	1908		1909		1910	
				Above 30° B.	Below 30° B.	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	$0.60	$0.52
February	....	.79	.65¼	.68	.60	.68	.60	.60	.52
March	....	.79	.67½	.68	.60	.68	.60	.60	.52
April	....	.80⅝	.68	.68	.60	.68	.60	.60	.52
May	....	.83	.68	.68	.60	.68	.60	.60	.52
June	$0.60	.83	.68	.68	.60	.67½	.59½	.60	.52
July	.60	.82¾	.68	.68	.60	.63⅜	.55⅜	.60	.52
August	.60	.71⅞	.68	.68	.60	.62	.54	.60	.52
September	.61	.64	.68	.68	.60	.62	.54	.60	.52
October	.64	.64	.68	.68	.60	.61¼	.53¼	.60	.52
November	.66	.64	.68	.68	.60	.60	.52	.60	.52
December	.70	.64	.68	.68	.60	.60	.52	.60	.52
Average	.644	.745	.67⅜	.68	.60	.64⅝	.56⅝	.60	.52

WELL RECORD.

In the following tables is given the well record for Illinois from 1906 to 1910, inclusive:

Number of wells completed in Illinois, 1906–1910, by counties.

County.	Completed.					Dry.					Productive.				
	1906	1907	1908	1909	1910	1906	1907	1908	1909	1910	1906	1907	1908	1909	1910
Bond	.....	.....	.....	.....	7	.....	.....	.....	.....	6	.....	.....	.....	.....	1
Clark	1,337	1,176	385	181	112	164	201	87	47	32	1,173	975	298	134	80
Coles	65	56	9	12	5	14	11	1	3	1	51	45	8	9	4
Crawford	1,060	2,840	2,322	2,093	1,210	164	376	336	355	260	896	2,464	1,986	1,738	950
Cumberland	558	152	42	33	17	53	13	11	10	4	505	139	31	23	13
Edgar	37	25	9	6	2	16	14	2	4	2	21	11	7	2	.....
Hancock	.....	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
Jackson	.....	.....	.....	3	2	.....	.....	.....	2	2	.....	.....	.....	1	.....
Jasper	.....	.....	.....	18	8	.....	.....	.....	11	4	.....	.....	.....	7	4
Lawrence	176	691	762	724	689	33	70	78	56	95	143	621	684	668	594
Macoupin	.....	.....	.....	9	2	.....	.....	.....	8	2	.....	.....	.....	1	.....
Madison	.....	.....	.....	2	1	.....	.....	.....	1	1	.....	.....	.....	1	.....
Marion	.....	.....	.....	23	60	.....	.....	.....	17	26	.....	.....	.....	6	34
Randolph	.....	.....	.....	12	.....	.....	.....	.....	10	.....	.....	.....	.....	2	.....
Saline	.....	.....	.....	2	1	.....	.....	.....	1	1	.....	.....	.....	1	.....
Miscellaneous	50	48	45	33	32	46	43	40	33	32	4	5	5	.....	.....
Total	3,283	4,988	3,574	3,151	2,149	490	728	555	558	[a] 468	2,793	4,260	3,019	2,593	1,681

[a] Includes 75 wells producing gas.

Number of wells completed in Illinois, 1906–1910, 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
1910	111	158	128	157	192	211	172	245	234	198	177	166	2,149

Number of dry holes drilled in Illinois, 1906–1910, 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
1910	17	43	29	41	43	50	43	47	48	30	39	38	[a] 468

[a] Includes 75 wells producing gas.

Total and average initial daily production of new wells in Illinois, 1906–1910, by counties, in barrels.

County.	Total initial production.					Average initial production per well.				
	1906	1907	1908	1909	1910	1906	1907	1908	1909	1910
Bond	....	....	....	....	25	....	....	....	....	25.0
Clark	31,060	20,385	6,953	3,219	1,802	26.5	20.9	23.3	24.0	22.5
Coles	279	314	122	95	65	5.5	7.0	15.3	10.6	16.3
Crawford	59,204	84,163	46,694	44,379	26,382	66.1	34.2	23.5	25.5	27.8
Cumberland	15,115	3,612	303	558	162	29.9	26.0	9.8	24.3	12.5
Edgar	101	118	45	10	....	4.8	10.7	6.4	5.0	....
Hancock	....	....	....	....	5	....	....	....	....	5.0
Jackson	....	....	....	3	....	....	....	....	3.0	....
Jasper	....	....	....	50	40	....	....	....	7.1	10.0
Lawrence	7,230	30,543	24,793	41,056	61,015	50.6	49.2	36.2	61.5	102.7
Macoupin	....	....	....	5	....	....	....	....	5.0	....
Madison	....	....	....	10	....	....	....	....	10.0	....
Marion	....	....	....	223	3,760	....	....	....	37.2	110.6
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	93,256	40.5	32.7	26.2	34.6	55.5

Total initial daily production of new wells in Illinois, 1906–1910, 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
1910	5,331	6,840	5,593	7,260	8,091	9,267	6,386	10,042	8,419	10,133	8,832	7,062	93,256

MID-CONTINENT OIL FIELD.

GENERAL CONDITIONS.

The price of crude oil increased gradually in the Mid-Continent field during 1910 from 28 cents for heavy oil to 42 cents for all grades. This was due to a slight drain on the large stocks during the first part of the year and to increased demand for fuel oil. Production rose with the price from 49,804,922 barrels in 1909 to 53,875,072 barrels in 1910, an increase of 4,070,150 barrels, or 8.17 per cent. In spite of low prices, the yield of the Mid-Continent region has increased every year for the last 20 years, with the exception of a very slight decline in 1902. In 1910 the increase was accomplished in spite of a very severe drought which greatly discouraged new drilling. The stock in the hands of pipe lines and other transportation companies remained almost stationary, being 49,629,362 barrels on December 31, 1909, and 50,035,523 barrels on December 31, 1910. Unsold stock in the hands of producers largely disappeared. The most favorable trade feature of the field was the increase in transportation facilities to the seacoast by way of Baton Rouge, La.

Production and value of petroleum in the Mid-Continent field, 1906–1910, by States, in barrels.

Year.	Kansas and Oklahoma.		Northern Texas.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
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
1910	53,157,386	20,367,423	717,686	402,554	53,875,072	20,769,977

Production of petroleum in the Mid-Continent field in 1909 and 1910, by months in barrels.

Month.	1909				1910			
	Kansas.	Oklahoma.	Northern Texas.	Total.	Kansas.	Oklahoma.	Northern Texas.	Total.
January	109,287	3,844,553	55,723	4,009,563	91,908	4,281,251	61,950	4,435,109
February	109,436	3,436,876	48,400	3,594,712	80,899	3,738,386	58,581	3,877,866
March	120,191	3,972,776	54,432	4,147,399	95,405	4,786,204	66,915	4,948,524
April	116,120	3,684,679	52,325	3,853,124	89,461	5,149,595	61,961	5,301,017
May	110,824	4,014,454	50,860	4,176,138	96,637	4,554,471	60,399	4,711,507
June	108,843	4,364,423	52,909	4,526,175	97,773	4,502,190	60,691	4,660,654
July	103,771	4,020,178	55,947	4,179,896	90,581	4,419,814	56,734	4,567,129
August	105,214	4,112,421	56,856	4,274,491	98,898	4,308,760	60,521	4,468,179
September	100,472	4,231,574	58,448	4,390,494	94,859	4,147,597	56,355	4,298,811
October	97,886	4,023,977	59,667	4,181,530	97,888	4,153,469	56,963	4,308,320
November	96,403	4,132,394	75,578	4,304,375	92,133	3,955,600	54,960	4,102,693
December	85,317	4,020,913	60,795	4,167,025	102,226	4,031,381	61,656	4,195,263
Total	1,263,764	47,859,218	681,940	49,804,922	1,128,668	52,028,718	717,686	53,875,072

PRODUCTION IN KANSAS AND OKLAHOMA.

Production of petroleum in Kansas and Oklahoma in 1909 and 1910, by months, in barrels.

Month.	1909			
	Runs from wells.		Shipped by rail and fuel consumption not included in pipe-line runs.	Total.
	Gulf, Prairie, and Texas companies' pipe lines.	Chelsea, Cherokee, Muskogee, Nowata, and other lines to refineries.		
January	3,564,267	181,568	208,005	3,953,840
February	3,267,782	179,827	98,703	3,546,312
March	3,789,545	184,520	118,902	4,092,967
April	3,439,825	192,892	168,082	3,800,799
May	3,695,785	189,186	240,307	4,125,278
June	4,032,636	190,195	250,435	4,473,266
July	3,680,984	188,024	254,941	4,123,949
August	3,826,469	196,748	194,418	4,217,635
September	3,936,080	206,140	189,826	4,332,046
October	3,755,164	216,111	150,588	4,121,863
November	3,796,698	229,826	202,273	4,228,797
December	3,686,631	225,906	193,693	4,106,230
Total	44,471,866	[a] 2,380,943	2,270,173	49,122,982

Month.	1910			
	Runs from wells.		Shipped by rail and fuel consumption not included in pipe-line runs.	Total.
	Gulf, Prairie, and Texas companies' pipe lines.	Alluwe, Chelsea, Cherokee, Muskogee, National Refining, Nowata, and other lines to refineries.		
January	3,773,499	316,315	191,437	4,281,251
February	3,237,303	323,750	177,333	3,738,386
March	4,071,046	364,657	350,501	4,786,204
April	4,486,871	367,721	295,003	5,149,595
May	3,907,563	389,096	257,812	4,554,471
June	4,031,123	386,606	84,461	4,502,190
July	3,964,964	394,162	60,688	4,419,814
August	3,817,891	418,307	72,562	4,308,760
September	3,698,588	409,494	39,515	4,147,597
October	3,705,210	406,962	41,297	4,153,469
November	3,498,567	422,622	34,411	3,955,600
December	3,518,126	477,358	35,897	4,031,381
Total	45,710,751	[a] 4,677,050	1,640,917	52,028,718

[a] Quantity run by other lines, averaged.

PRICES.

In the following tables are given the prices paid by the Prairie Oil & Gas Co. for petroleum of different grades in Kansas and Oklahoma during 1907 to 1910, also the average monthly price during these years:

Range of prices paid per barrel for petroleum by the Prairie Oil & Gas Co. in Kansas and Oklahoma, 1907 to 1910.

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.							1910.		
Jan. 1	.41	.38	.35	.32	.29	.28	Jan. 1	.35	.28
							Mar. 17	.38	.30
							Sept. 2	.40	.30
							Sept. 20	.40	.40
							Nov. 14	.42	.42

Average monthly price of Kansas and Oklahoma petroleum, per barrel of 42 gallons, 1907–1910, by months.

Month.	1907		1908				1909		1910	
			Kansas.		Oklahoma.					
	32° B. and above.	Heavy.	Light.	Heavy.	Light.	Heavy.	Above 30° B.	Below 30° B.	Above 30° B.	Below 30° B.
January	$0.39	$0.26	$0.41	$0.308	$0.41	$0.325	$0.41	$0.28	$0.35	$0.28
February	.39⅝	.26⅝	.41	.306	.41	.324	.41	.28	.35	.28
March	.40¾	.27¾	.41	.297	.41	.326	.41	.28	.36⅜	.29
April	.41	.28	.41	.302	.41	.321	.41	.28	.38	.30
May	.41	.28	.41	.308	.41	.320	.41	.28	.38	.30
June	.41	.28	.41	.297	.41	.320	.41	.28	.38	.30
July	.41	.28	.41	.307	.41	.317	.37	.28	.38	.30
August	.41	.28	.41	.312	.41	.322	.35	.28	.38	.30
September	.41	.28	.41	.300	.41	.322	.35	.28	.40	.34¼
October	.41	.28	.41	.310	.41	.326	.35	.28	.40	.40
November	.41	.28	.41	.303	.41	.326	.35	.28	.41⅛	.41⅛
December	.41	.28	.41	.302	.41	.312	.35	.28	.42	.42
Average	.40¾	.27¾	.41	.304	.41	.322	.38⅛	.28	.38¼	.32¾

KANSAS.

The production in Kansas declined from 1,263,764 barrels in 1909 to 1,128,668 barrels in 1910, or 10.69 per cent. Drilling was active in Allen, Chautauqua, Neosho, Montgomery, and Wilson counties, owing to the rise in price of heavy oil from 28 cents to 42 cents per barrel during the year. A total of 85 oil wells and about the same number of dry holes were drilled, as shown in the tables below.

Production.—The following table gives the production and sales of petroleum in Kansas in 1907, 1908, 1909, and 1910:

Production of petroleum in Kansas, 1907–1910, in barrels.

	1907	1908	1909	1910
Quantity piped from wells in Kansas to refineries	449,211	492,966	466,298	388,013
Rail shipments in Kansas	263,881	149,056	52,261	21,590
Estimated quantity piped from other wells in Kansas and sold	1,696,429	1,159,759	745,205	719,065
Total sales in Kansas	2,409,521	1,801,781	1,263,764	1,128,668
Total value	$965,134	$746,695	$491,633	$444,763

Well record.—The following tables give the well record for Kansas from 1906 to 1910, inclusive:

Number of wells completed in Kansas, 1906–1910, by counties.

County.	Completed.					Oil.				
	1906	1907	1908	1909	1910	1906	1907	1908	1909	1910
Allen	2	45	192	151	78	......	6	22	16	13
Anderson	......	......	9	1	......	......	......	......	......	......
Bourbon	16	......	......	......	......	8	......	......	......	......
Chautauqua	156	47	24	31	60	125	20	16	23	42
Elk	2	......	......	9	1	1	......	......	7	......
Franklin	72	16	2	7	3	63	9	1	......	1
Labette	4	......	......	11	3	1	......	......	......	1
Miami	38	10	6	......	......	25	5	......	......	......
Montgomery	169	56	97	127	79	60	21	1	5	16
Neosho	165	112	118	100	87	68	7	30	18	9
Wilson	81	57	87	113	108	7	......	......	......	1
Woodson	......	......	......	2	......	......	......	......	......	......
Miscellaneous	74	25	31	6	9	8	......	2	......	2
Total	779	368	566	558	428	306	68	72	69	85

County.	Gas.					Dry.				
	1906	1907	1908	1909	1910	1906	1907	1908	1909	1910
Allen	2	37	133	100	51	......	2	37	35	14
Anderson	......	......	9	1	......	......	......	......	......	......
Bourbon	6	......	......	......	......	2	......	......	......	......
Chautauqua	6	17	5	5	4	25	10	3	3	14
Elk	......	......	......	2	1	1	......	......	......	......
Franklin	1	1	......	6	2	8	6	1	1	......
Labette	3	......	......	8	2	......	......	......	3	......
Miami	5	3	6	......	......	8	2	......	......	......
Montgomery	88	31	79	100	56	21	4	17	22	7
Neosho	61	87	54	65	61	36	18	34	17	17
Wilson	48	47	66	89	80	26	10	21	24	27
Woodson	......	......	......	2	......	......	......	......	......	......
Miscellaneous	42	13	15	5	4	24	12	14	1	3
Total	262	236	367	383	261	151	64	127	106	82

Number of wells completed in Kansas, 1906–1910, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
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
1910	45	48	42	40	34	29	36	25	30	47	28	24	428

Number of dry holes drilled in Kansas, 1906–1910, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
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
1910	9	8	12	10	7	4	5	2	7	9	5	4	82

Number of gas wells drilled in Kansas, 1906–1910, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
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
1910	36	35	27	26	22	23	23	16	11	24	12	6	261

Total and average initial daily production of new wells in Kansas, 1906–1910, by counties, in barrels.

County.	Total initial production.					Average initial production per well.				
	1906	1907	1908	1909	1910	1906	1907	1908	1909	1910
Allen	....	89	365	251	210	....	14.8	16.6	15.7	16.2
Bourbon	135	....	....	....	....	16.9	....	....	....	....
Chautauqua	2,920	358	305	475	1,100	23.4	17.9	19.1	20.7	26.2
Elk	10	....	....	110	....	10.0	....	....	15.7	....
Franklin	597	95	8	....	5	9.5	10.6	8.0	....	5.0
Labette	10	....	....	....	20	10.0	....	....	....	20.0
Miami	203	41	....	....	....	8.1	8.2	....	....	....
Montgomery	854	213	15	113	382	14.2	10.1	15.0	22.6	23.9
Neosho	802	90	446	360	130	11.8	12.9	14.9	20.0	14.4
Wilson	105	....	....	....	10	15.0	....	....	....	10.0
Miscellaneous	125	....	20	....	40	15.6	....	10.0	....	20.0
Total	5,761	886	1,159	1,309	1,897	15.7	13.0	16.1	19.0	22.3

Total initial daily production of new wells in Kansas, 1906–1910, by months, in barrels.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
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
1910	....	95	65	95	170	40	235	200	257	305	210	225	1,897

OKLAHOMA.

General conditions.—The production of Oklahoma increased from 47,859,218 barrels in 1909 to 52,028,718 barrels in 1910, or 8.71 per cent. The value increased, in greater proportion, to $19,922,660, or 14.31 per cent, owing to the rise in price.

A stimulating trade feature was the sale in April of some 20 companies to the Central Fuel Oil Co. This involved a welcome influx of outside capital to the State. The extensions to the oil fields included the discovery of gas in an anticline near Poteau, Le Flore County, which was pointed out by Charles N. Gould, then State geologist. In July a well drilled 1,800 feet deep near Henryetta, in Okmulgee County, yielded 600 barrels a day and was the cause of sufficient drilling to prove that the field is very spotted. In September the Highland Oil Co.'s No. 3 well proved a gas well with an estimated capacity of 84,000,000 feet per day.

Late in the year deep wells of large capacity were developed near Osage Junction, Osage County, and their development has become the feature of dominant interest in 1911.

Production.—The following table shows the production and sales of petroleum in Oklahoma from 1907 to 1910:

Production of petroleum in Oklahoma, 1907–1910, in barrels.

	1907	1908	1909	1910
Estimated quantity shipped from Glenn pool and sold	19,926,995	20,494,313	18,946,740	19,236,914
Estimated quantity piped from other wells in Oklahoma and sold	23,422,178	25,012,423	28,330,313	32,124,072
Rail shipments (outside Glenn pool) in Oklahoma	174,955	292,029	582,165	667,732
Total sales in Oklahoma	43,524,128	45,798,765	47,859,218	52,028,718
Total value	$17,513,524	$17,694,843	$17,428,990	$19,922,660

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, 1889–1910, by States, in barrels.

Year.	Kansas.	Oklahoma.	Northern Texas.[a]	Total.	Percentage of total production.	Increase.	Percentage of increase.
1889	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	.08	22,120	122.82
1895	44,430	37		44,467	.08	4,337	10.81
1896	113,571	170	1,400	115,141	.19	70,674	158.93
1897	81,098	625	65,925	147,648	.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	27.19	1,481,112	3.06
1910	1,128,668	52,028,718	717,686	53,875,072	25.71	4,070,150	8.17

[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.

The following table gives a statement of the quantity of petroleum produced by the Indian Territory Illuminating Oil Co. and its sublessees from wells in Osage County from 1903 to 1910, inclusive:

Production of petroleum by the Indian Territory Illuminating Oil Co. and its sublessees from Jan. 1, 1903, to Dec. 31, 1910.

	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	1910	5,892,970

The total production of petroleum and the value of royalty oil and gas received by Osage Nation from wells in Osage County during the year 1910 were as follows:

Total production of petroleum and value of royalty oil and gas from wells in Osage County during the year 1910.

Received by—	Total quantity produced.	Amount received by Osage Nation for royalty of one-eighth of production.
	Barrels.	
Prairie Oil and Gas Co	5,467,599	$264,837.83
Gulf Pipe Line Co	374,977	18,913.22
Uncle Sam Oil Co	35,038	1,809.49
Southwestern Refining Co	14,287	888.28
Groves, Stearns & Fisher	269	12.78
American Oil and Gas Co	800	38.00
Total	5,892,970	286,499.60
Royalty received by Osage Nation for gas		3,135.66
Grand total		289,635.26

There were 96 oil-producing properties in Osage County, Okla., at the close of the year 1910.

In the following table is shown the number of wells owned in Osage County by the Indian Territory Illuminating Oil Co. and its sublessees from 1903 to 1910, inclusive.

Oil and gas wells in Osage County, 1903–1910.

Total wells to—	Completed.	Productive.	Gas.	Dry.[a]
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
Dec. 31, 1910	1,735	1,175	82	478

[a] Wells which have been exhausted and abandoned in addition to wells that were dry when drilled in.

In the following table is given the production of petroleum in the Glenn pool (Creek County) for the last three years:

Estimated production and sales of petroleum from Glenn pool, 1907–1910, by months, in barrels.

Month.	1907	1908	1909	1910
January	385,939	1,796,461	1,362,602	1,745,206
February	572,414	1,897,054	1,410,878	1,543,660
March	1,084,636	2,098,411	1,543,463	1,974,514
April	1,716,079	1,968,761	1,467,179	1,674,709
May	1,923,262	1,630,111	1,590,730	1,676,366
June	1,971,122	1,051,045	1,809,989	1,573,578
July	1,922,387	1,914,134	1,856,524	1,557,869
August	2,003,607	1,770,819	1,699,486	1,609,702
September	2,309,205	1,639,252	1,670,167	1,593,986
October	2,441,622	1,832,033	1,602,988	1,521,794
November	1,971,595	1,404,234	1,539,342	1,400,118
December	1,625,127	1,491,998	1,393,392	1,365,412
Total	19,926,995	20,494,313	18,946,740	19,236,914

Well record.—The following table gives the well record for Oklahoma for 1909 and 1910, by districts and pools:

Well record in Oklahoma in 1909 and 1910, by districts and pools.

District and pool.	1909						1910					
	Wells completed.				Initial daily production.		Wells completed.				Initial daily production.	
	Total.	Oil.	Dry.	Gas.	Total.	Average per well.	Total.	Oil.	Dry.	Gas.	Total.	Average per well.
					Bbls.	*Bbls.*					*Bbls.*	*Bbls.*
Cherokee, deep sand...	652	519	62	71	34,130	65.8	802	627	61	114	28,903	46.1
Bartlesville........	254	238	11	5	11,475	48.2	251	232	11	8	10,196	43.9
Bird Creek........	101	78	17	6	3,595	46.1	188	165	20	3	9,510	57.6
Copan............	95	43	17	35	2,340	54.4	208	121	22	65	4,082	33.7
Flat Rock........	95	89	5	1	12,970	145.7	.....	.....	.....	.....	.....	.....
Hogshooter........	107	71	12	24	3,750	50.0	155	109	8	38	5,115	46.9
Cherokee, shallow sand	1,724	1,535	169	20	90,864	59.2	1,830	1,665	152	13	85,147	51.1
Alluwe............	246	222	24	.....	7,196	32.4	190	182	7	1	4,645	25.5
Catoosa...........	4	3	1	.....	70	23.3	.....	.....	.....	.....	.....	.....
Chelsea...........	262	224	38	.....	7,405	33.1	351	322	25	4	7,920	24.6
Claremore.........	2	2	.....	.....	13	6.5	.....	.....	.....	.....	.....	.....
Coodys Bluff......	72	69	3	.....	1,565	22.7	73	67	6	.....	1,625	24.3
Collinsville........	11	.....	2	9	.....	.....	4	.....	4	.....	.....	.....
Delaware-Childers.	546	475	65	6	57,320	120.7	757	673	80	4	59,185	88.0
Dewey............	161	152	8	1	5,065	33.3	192	188	3	1	6,073	32.3
Nowata...........	232	213	15	4	5,620	26.4	109	103	4	2	2,150	20.9
Ochelata..........	92	81	11	.....	2,805	34.6	99	81	17	1	2,274	28.1
Salt Creek.........	96	94	2	.....	3,805	40.5	55	49	6	.....	1,275	26.0
Cleveland.............	28	23	3	2	1,865	81.1	13	10	2	1	713	71.3
Creek.................	733	582	114	37	68,710	118.1	837	657	142	38	76,485	116.4
Beggs.............	2	.....	2	.....	.....	.....	3	.....	3	.....	.....	.....
Glenn Pool........	89	80	5	4	6,240	78.0	84	72	6	6	4,505	62.6
Haskell...........	10	5	5	.....	460	92.0	29	16	12	1	1,800	112.5
Keystone..........	.....	.....	.....	.....	.....	.....	12	7	5	.....	405	57.9
Morris-Okmulgee..	39	14	22	3	2,010	143.6	84	54	25	7	5,865	108.6
Mounds...........	11	.....	10	1	.....	.....	.....	.....	.....	.....	.....	.....
Muskogee..........	129	79	41	9	8,245	104.4	171	123	43	5	16,640	135.3
Preston...........	9	8	.....	1	2,300	287.5	97	68	22	7	13,540	199.1
Redfork...........	5	3	2	.....	35	11.7	1	1	.....	.....	20	20.0
Sapulpa...........	10	7	3	.....	150	21.4	.....	.....	.....	.....	.....	.....
Taneha............	357	332	19	6	43,130	129.9	306	284	15	7	31,050	109.3
Tulsa.............	6	3	1	2	45	15.0	19	10	7	2	605	60.5
Twin Hills........	66	51	4	11	6,095	119.5	31	24	4	3	2,055	85.6
Osage.................	108	75	15	18	10,205	136.1	239	206	25	8	35,060	170.2
Miscellaneous.........	34	8	17	9	680	85.0	56	23	26	7	330	14.3
Total............	3,279	2,742	380	157	206,454	75.3	3,777	3,188	408	181	226,638	71.1

Number of wells completed in Oklahoma, 1906–1910, by districts.

District.	Completed.					Dry.					Gas.					Oil.				
	1906	1907	1908	1909	1910	1906	1907	1908	1909	1910	1906	1907	1908	1909	1910	1906	1907	1908	1909	1910
Cherokee, deep.	.....	941	690	652	802	...	65	53	62	61	...	61	32	71	114	.....	815	605	519	627
Bartlesville	790	.....	.....	.....	.....	123	...	...	...	...	61	...	...	...	...	606	.....	.....	.....	.....
Cherokee, shallow..........	.....	1,537	1,281	1,724	1,830	...	120	91	169	152	...	14	7	20	13	.....	1,403	1,180	1,535	1,665
Alluwe.....	441	.....	.....	.....	.....	25	...	...	...	...	7	...	...	...	...	409	.....	.....	.....	.....
Chelsea.....	400	.....	.....	.....	.....	44	...	...	...	...	8	...	...	...	...	348	.....	.....	.....	.....
Coodys Bluff.....	549	.....	.....	.....	.....	28	...	...	...	...	11	...	...	...	...	510	.....	.....	.....	.....
Creek..........	211	1,225	683	733	837	41	97	106	114	142	35	38	52	37	38	135	1,090	525	582	657
Oklahoma......	107	36	.....	.....	.....	50	12	...	...	...	19	8	...	...	...	38	16	.....	.....	.....
Cleveland..	.....	.....	22	28	13	...	...	7	3	2	...	...	1	2	1	.....	.....	14	23	10
Osage..........	262	184	153	108	239	30	15	16	15	25	17	15	8	18	8	215	154	129	75	206
Miscellaneous..	19	33	15	34	56	7	9	8	17	26	5	12	2	9	7	7	12	5	8	23
Total.....	2,779	3,956	2,844	3,279	3,777	348	318	284	380	408	163	148	102	157	181	2,268	3,490	2,458	2,742	3,188

Number of wells completed in Oklahoma, 1906–1910, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
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
1910	262	313	325	348	377	378	274	269	306	329	343	253	3,777

Number of dry holes drilled in Oklahoma, 1906–1910, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
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
1910	25	48	41	41	36	40	31	17	50	28	28	23	408

Number of gas wells drilled in Oklahoma, 1906–1910, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
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
1910	29	25	13	14	20	27	6	4	14	9	5	15	181

Total and average initial daily production of new wells in Oklahoma, 1906–1910, by districts, in barrels.

District.	Total initial production.					Average initial production per well.				
	1906	1907	1908	1909	1910	1906	1907	1908	1909	1910
Cherokee, deep		74,824	36,561	34,130	28,903		91.8	60.4	65.8	46.1
Bartlesville	44,367					73.2				
Cherokee, shallow		64,490	80,923	90,864	85,147		45.9	68.6	59.2	51.1
Alluwe	13,749					33.6				
Chelsea	6,828					19.6				
Coodys Bluff	22,845					44.8				
Creek	51,728	303,005	76,722	68,710	76,485	383.2	277.9	146.1	118.1	116.4
Oklahoma	1,562	534				41.1	33.4			
Cleveland			455	1,865	713			32.5	81.1	71.3
Osage	20,047	16,355	19,377	10,205	35,060	93.2	106.2	150.2	136.1	170.2
Miscellaneous	160	654	114	680	330	22.9	54.5	22.8	85.0	14.3
Total	161,286	459,862	214,152	206,454	226,638	71.1	131.7	87.1	75.3	71.1

Total initial daily production of new wells in Oklahoma, 1906–1910, by months, in barrels.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
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
1910	15,840	17,785	20,915	18,932	19,545	26,378	14,915	16,680	18,998	18,585	17,915	20,150	226,638

GULF OIL FIELD.

PRODUCTION.

Although Texas showed a slight decline, the total for the Gulf field, including all of Louisiana, showed an increase from 11,912,058 barrels in 1909 to 15,022,975 barrels in 1910. Louisiana more than doubled the output of 1909 because of the phenomenal gushers which developed in the Caddo field. The summary for the entire field is given below.

Production of petroleum in the Gulf field in 1909 and 1910, by months, in barrels.

Month.	1909			1910		
	Coastal Texas.	Louisiana.	Total.	Coastal Texas.	Louisiana.	Total.
January	856,861	301,729	1,158,590	645,045	253,492	898,537
February	775,234	265,434	1,040,668	578,583	283,674	862,257
March	804,045	288,099	1,092,144	635,709	367,239	1,002,948
April	745,395	227,710	973,105	623,732	384,538	1,008,270
May	769,004	247,590	1,016,594	641,371	536,682	1,178,053
June	730,123	237,034	967,157	627,690	717,708	1,345,398
July	742,755	245,158	987,913	636,685	660,102	1,296,787
August	714,256	249,481	963,737	692,787	520,725	1,213,512
September	682,984	218,008	900,992	708,697	911,800	1,620,497
October	678,385	229,617	908,002	748,441	929,417	1,677,858
November	683,207	265,137	948,344	784,227	637,794	1,422,021
December	670,278	284,534	954,812	858,613	638,224	1,496,837
Total	8,852,527	3,059,531	11,912,058	8,181,580	6,841,395	15,022,975

Production and value of petroleum produced in the Gulf field, 1901-1910, 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
1910	8,181,580	6,203,201	6,841,395	3,574,069	15,022,975	9,777,270

In the following table is shown the production of petroleum in the Gulf field from 1889 to 1910, 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, 1889–1910, in barrels.

Year.	Production.	Percentage of total production.	Increase.	Decrease.	Percentage.	
					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	6.50		4,360,016		26.79
1910	15,022,975	7.17	3,110,917		26.12	

TEXAS.

GENERAL CONDITIONS.

The anticipated rate of decrease in the older Texas fields was somewhat checked in 1910, the total output—that of northern Texas included—amounting to 8,899,266 barrels against 9,534,467 barrels in 1909, a decline of 6.66 per cent. The decline in value was even less, owing to an increased average price from $0.712 to $0.742 per barrel.

Early in March a 2,000-barrel gusher at Hoskins Mound, Tex., renewed the interest in this locality. In April a gusher was drilled in the eastern part of the proved area of the Humble field at a greater depth than in any well previously sunk in that region. The well soon choked up and added little to the total product, but it served to promote deeper drilling in this locality. Interest was again aroused in the hitherto disappointing Markham pool, in Matagorda County, by the drilling of several large gushers. One drilled in April and one in December were rated at 10,000 barrels a day and two others yielded over 3,000 barrels a day.

Outside of the developed fields the usual amount of wildcatting was distributed over the entire State. Texas is remarkable for the hundreds of localities where indications of oil are sufficient to tempt the drill. Seepages of natural gas and oil, tar springs, outcroppings of sandstones and limestones showing evidence of oil and asphalt, springs showing sulphureted hydrogen, beds of gypsum, and other "oil signs" are found very generally distributed.

No list of these oil indications is possible, but the following items show the widespread interest in searching for oil in Texas. Oil was found in a well drilled in Brown County, and again at Cuevitas in the southern part of Starr County. Piedras Pintas, Duval County, reported several small producers. Drilling was active near San Antonio. Twenty miles northwest of Toyah, on the western edge of Reeves County in the Pecos Valley, the well-known shallow oil wells drilled several years ago were acquired by the Producers Oil Co., and two wells were drilled with prospects sufficiently encouraging to result in the purchase from the State of large blocks of land by several companies. Development must wait not only for a market but on the determination of the question whether the oil will go with the surface rights or whether oil rights must separately be leased from the State. Leasing was active near Christoval, in Tom Green County, and in McMullen County. One of the large companies leased a large tract of land near Wichita, in Wilbarger and Archer counties. Traces of oil were noted at 342 feet in a well drilled for water in the northern part of the city of Dallas. The two gushers in the Henrietta pool, Clay County, attracted great attention to that region, which has continued to be the scene of interest during 1911. The drilling operations in the Caddo fields has caused much prospecting in Marion County, Tex., across the line from Louisiana. The wells adjoining the Louisiana line have many of them proved productive. There is tendency also for much wildcatting farther west. In the Corsicana-Petrolia field a deep well (1,770 feet) drilled in on June 3 proved an exceptional producer. In the old Sour Lake field, the Crosby Oil Co. obtained a 100-barrel gusher at the end of May, thus developing a valuable extension to the field. The Mount Oil Co. secured a 600-barrel well in adjoining territory.

The effect of these wildcatting operations on the production of 1911 will be small, except as developments may be made in Clay County.

PRODUCTION.

Production and value of petroleum in northern and coastal Texas, 1901–1910, in barrels.

Year.	Northern Texas.		Coastal Texas.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
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
1910	717,686	402,554	8,181,580	6,203,201	8,899,266	6,605,755

In the following table will be found the production of petroleum in Texas, by districts and months, for the years 1909 and 1910:

Production of petroleum in Texas, 1909–10, by districts and months, in barrels.

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

[a] Includes South Bosque and Brown County.

Production of petroleum in Texas, 1909–10, by districts and months, in barrels—Continued.

1909—Continued.

Month.	Coastal Texas.					Total.
	Saratoga.	Sour Lake.	Spindletop.	Other.[a]	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

1910.

Month.	Northern Texas.				Coastal Texas.		
	Corsicana.	Henrietta.	Powell.	Total.[b]	Batson.	Humble.	Marion and Matagorda counties.[c]
January	10,953	11,788	38,906	61,950	83,342	231,138	1,730
February	13,661	9,423	35,194	58,581	88,515	191,449	2,485
March	16,182	10,115	40,315	66,915	88,142	219,980	1,330
April	11,186	11,116	39,356	61,961	85,275	211,513	1,914
May	11,947	10,614	37,535	60,399	95,102	220,367	2,629
June	11,433	10,674	38,281	60,691	100,427	190,992	3,425
July	10,382	8,821	37,228	56,734	102,671	200,415	6,652
August	12,046	9,419	38,753	60,521	100,573	204,355	67,688
September	10,295	9,747	36,010	56,355	89,732	186,495	94,589
October	9,979	9,962	36,719	56,963	100,511	226,963	105,371
November	9,636	8,767	36,254	54,960	90,299	208,644	172,387
December	9,631	16,085	35,637	61,656	89,178	203,200	247,516
Total	137,331	126,531	450,188	717,686	1,113,767	2,495,511	707,716

Month.	Coastal Texas.					Total.
	Saratoga.	Sour Lake.	Spindletop.	Other.[d]	Total.	
January	86,556	112,241	118,740	11,298	645,045	706,995
February	79,076	100,234	104,568	12,256	578,583	637,164
March	89,813	110,737	111,897	13,810	635,709	702,624
April	92,862	113,975	107,156	11,037	623,732	685,693
May	86,790	123,540	100,983	11,960	641,371	701,770
June	89,148	137,991	94,413	11,294	627,690	688,381
July	88,243	139,392	87,428	11,884	636,685	693,419
August	87,066	138,799	83,777	10,529	692,787	753,308
September	87,030	146,200	93,042	11,609	708,697	765,052
October	80,436	132,490	91,128	11,542	748,441	805,404
November	79,146	130,618	92,448	10,685	784,227	839,187
December	78,182	132,506	96,856	11,175	858,613	920,269
Total	1,024,348	1,518,723	1,182,436	139,079	8,181,580	8,899,266

[a] Includes Dayton, Goose Creek, Hoskins Mound, Matagorda County, Piedras Pintas, and Mission fields.
[b] Includes South Bosque and Brown County.
[c] Includes Potters Point, Markham, and Big Hill.
[d] Includes Dayton, Goose Creek, Hoskins Mound, Piedras Pintas.

The production of petroleum in Texas from 1901 to 1910, inclusive, has been as follows:

Production of petroleum in Texas, 1901–1910, by districts, in barrels.

Year.	Northern Texas.				Coastal Texas.		
	Corsicana.	Henrietta.	Powell.	Total.[a]	Batson.	Dayton.	Humble.
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
1910	137,331	126,531	450,188	717,686	1,113,767	9,582	2,495,511

Year.	Coastal Texas.						Total.
	Matagorda County.	Saratoga.	Sour Lake.	Spindletop.	Other.	Total.	
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
1910	455,999	1,024,348	1,518,723	1,182,436	384,850	8,181,580	8,899,266

[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 1909 and 1910, by districts:

Production and value of petroleum in Texas, in 1909 and 1910, by districts, in barrels.

District.	1909			1910		
	Quantity.	Value.	Price per barrel.	Quantity.	Value.	Price per barrel.
Northern Texas:						
Corsicana	180,764	$130,335	$0.721	137,331	$87,623	$0.638
Henrietta	113,485	58,694	.517	126,531	69,086	.546
Powell	383,137	199,952	.522	450,188	242,440	.538
Coastal Texas:						
Batson	1,206,214	851,138	.706	1,113,767	851,927	.765
Dayton	17,647	11,471	.65	9,582	6,815	.711
Humble	3,237,060	2,314,082	.715	2,495,511	1,927,879	.773
Matagorda	29,103	21,918	.753	455,999	250,050	.548
Saratoga	1,183,559	864,938	.738	1,024,348	789,761	.771
Sour Lake	1,703,798	1,227,734	.721	1,518,723	1,203,920	.793
Spindletop	1,388,107	1,041,791	.751	1,182,436	961,758	.813
Other Texas	[a] 91,593	70,997	.775	[b] 384,850	214,496	.557
Total	9,534,467	6,793,050	.712	8,899,266	6,605,755	.742

[a] Includes South Bosque and small production in Brown County in northern Texas and Goose Creek, Hoskins Mound, Piedras Pintas, and Mission fields in coastal Texas.

[b] Includes South Bosque and small production in Brown County in northern Texas and Goose Creek, Hoskins Mound, Piedras Pintas, and Potters Point 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 1909 and 1910:

Fluctuation in prices per barrel of petroleum in northern Texas, 1909 and 1910.

Corsicana (light).		Henrietta.		Powell (heavy).	
1909.		1909.		1909.	
Jan. 1	$0.70	Jan. 1	$0.48	Jan. 1	$0.48
		Mar. 13	.50	Mar. 13	.50
1910.		Apr. 27	.53	Apr. 27	.53
Jan. 1	.70				
May 23	.60	1910.		1910.	
Sept. 1	.58	Jan. 1	.53	Jan. 1	.53
Nov. 16	.55	Mar. 16	.55	Mar. 16	.55
				Sept. 1	.53
				Nov. 16	.50

The average monthly prices per barrel of petroleum at wells in northern Texas in the years 1908 to 1910, inclusive, were as follows:

Average monthly prices per barrel of petroleum in northern Texas, 1908–1910.

Month.	Corsicana (light).			Henrietta.			Powell (heavy.)		
	1908	1909	1910	1908	1909	1910	1908	1909	1910
January	$1.00	$0.70	$0.70	$0.93	$0.48	$0.53	$0.70	$0.48	$0.53
February	.98	.70	.70	.90	.48	.53	.70	.48	.53
March	$0.85– .95	.70	.70	$0.75– .85	.49⅛	.54	$0.65– .70	.49⅛	.54
April	.80– .85	.70	.70	.70– .75	.50½	.55	.60– .65	.50½	.55
May	.77– .80	.70	.67	.70	.53	.55	.57– .60	.53	.55
June	.70– .77	.70	.60	.45– .70	.53	.55	.45– .57	.53	.55
July	.70	.70	.60	.45	.53	.55	.45	.53	.55
August	.70	.70	.60	.45	.53	.55	.45	.53	.55
September	.70	.70	.58	.45	.53	.55	.45	.53	.53
October	.70	.70	.58	.45– .48	.53	.55	.45– .48	.53	.53
November	.70	.70	.56½	.48	.53	.55	.48	.53	.51½
December	.70	.70	.55	.48	.53	.55	.48	.53	.50
Average	.727	.70	.62⅞	.546	.51⅝	.54⅝	.65	.51⅝	.53½

The average monthly prices per barrel of petroleum at wells in coastal Texas in the years 1908 to 1910, inclusive, were as follows:

Average monthly prices per barrel of petroleum in coastal Texas, 1908–1910.

Month.	Batson.			Dayton.			Potter's Point.
	1908	1909	1910	1908	1909	1910	1910
January	$0.66–$0.84	$0.53–$0.60	$0.75–$0.79	$0.61	$0.50	....	....
February	.68– .73	.53– .60	.75– .80	.60	.50	$0.72	....
March	.67– .71	.53– .65	.75– .80	.60	.50	.72	....
April	.63	.66– .73	.75– .80	.57	.60	.72	....
May	.53– .58	.73	.75– .80	.50	.70	.72	....
June	.47– .51	.73	.75– .80	.44	.70	.72	....
July	.40	.74– .75	.75– .80	.36	.71	.70	$0.38
August	.40– .43	.75	.72– .79	.38	.72	....	.40
September	.44– .46	.75	.72– .79	.41	.72	.70	.40
October	.44– .52	.75– .77	.72– .79	.48	.72	.70	.40
November	.54– .55	.75– .77	.72– .79	.51	.72	.70	.41
December	.53	.75– .77	.72– .79	.50	.72	.70	.42
Average	.556	.706	.765–	.497	.65	.711+	.408+

Average monthly prices per barrel of petroleum in coastal Texas, 1908-1910—Continued.

Month.	Humble.			Saratoga.		
	1908	1909	1910	1908	1909	1910
January	$0.68 -$0.913	$0.54-$0.60	$0.75-$0.80	$0.66 -$0.887	$0.53 -$0.60	$0.75-$0.82
February	.725- .893	.54- .65	.75- .80	.70 - .725	.53 - .65	.75- .83
March	.69 - .869	.54- .70	.75- .80	.70 - .725	.53 - .65	.75- .84
April	.66 - .869	.65- .75	.75- .80	.64 - .725	.60 - .73	.75- .83
May	.60 - .725	.73- .75	.75- .80	.54 - .725	.725- .73	.75- .83
June	.51 - .725	.74- .75	.75- .80	.48 - .725	.725- .73	.75- .82
July	.43 - .482	.74- .75	.72- .79	.40 - .681	.725- .75	.70- .79
August	.44 - .45	.75	.72- .79	.43 - .45	.75	.72- .77
September	.436- .50	.75	.72- .79	.449- .46	.75	.72- .77
October	.497- .57	.75- .78	.72- .79	.451- .55	.75 - .80	.72- .76
November	.517- .56	.75- .80	.72- .79	.547- .55	.75 - .80	.72- .79
December	.533- .55	.75- .80	.72- .79	.53 - .55	.75 - .80	.72- .75
Average	.60	.715	.773-	.605	.738	.771-

Month.	Sourlake.			Spindletop.		
	1908	1909	1910	1908	1909	1910
January	$0.69 -$0.92	$0.54-$0.60	$0.77-$0.84	$0.71 -$0.791	$0.58-$0.60	$0.80-$0.82
February	.70 - .807	.54- .65	.77- .84	.70 - .717	.60- .65	.80- .82
March	.70 - .725	.54- .70	.77- .84	.69 - .713	.60- .70	.80- .82
April	.64 - .725	.65- .75	.77- .83	.64 - .687	.68- .75	.80- .83
May	.57 - .725	.75	.77- .83	.57 - .646	.75	.80- .83
June	.51 - .725	.75	.77- .83	.48 - .568	.75	.80- .83
July	.43 - .688	.75- .76	.75- .80	.408- .43	.77- .80	.77- .83
August	.44 - .45	.75- .77	.72- .80	.44 - .45	.80	.77- .83
September	.44 - .47	.75- .77	.72- .81	.462- .50	.80	.77- .83
October	.448- .55	.77- .80	.72- .79	.54 - .57	.80- .82	.77- .82
November	.55 - .552	.77- .80	.72- .76	.56 - .573	.80- .82	.77- .82
December	.533- .55	.77- .80	.72- .76	.58 - .60	.80- .82	.77- .82
Average	.616	.721	.793-	.589	.751	.813+

WELL RECORD IN NORTHERN TEXAS.

The following tables give the well records in northern Texas from 1907 to 1910, inclusive:

Number of wells completed in northern Texas, 1907-1910, by districts.

District.	Completed.				Dry.				Oil.			
	1907	1908	1909	1910	1907	1908	1909	1910	1907	1908	1909	1910
Corsicana	16	13	5	27	4	5	1	10	12	8	4	17
Henrietta	27	26	46	72	9	7	[a] 26	37	18	19	20	35
Powell	104	42	118	91	42	12	[b] 31	35	62	30	87	56
South Bosque	26	......	2	......	12	......	1	......	14	......	1	......
Other	......	......	4	......	......	......	......	......	......	......	4	......
Total	173	81	175	190	67	24	59	[c] 82	106	57	116	108

[a] Eleven gas. [b] Three gas. [c] Sixteen gas.

Number of wells completed in northern Texas, 1907-1910, 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
1910	([b])	26	19	29	15	20	22	12	21	8	12	6	190

[a] South Bosque not reported by months. [b] No record.

Number of dry holes drilled in northern Texas, 1907–1910, 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
1910	(a)	6	6	9	5	8	14	6	10	6	7	5	b 82

a No record. b Includes 16 gas wells.

Total and average initial daily production of new wells in northern Texas, 1907–1910, by districts, in barrels.

District.	Total initial production.				Average initial production per well.			
	1907	1908	1909	1910	1907	1908	1909	1910
Corsicana	36	41	25	54	3.0	5.1	6.2	3.2
Henrietta	222	718	484	1,331	12.3	37.8	24.2	38.0
Powell	830	368	668	298	13.4	12.3	7 8	5.3
South Bosque	59	......	......	......	4.2	......	......	......
Total	1,147	1,127	1,177	1,683	10.8	19.8	10.8	15.6

Total initial daily production of new wells in northern Texas, 1907–1910, 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
1910	(b)	210	77	83	43	1,044	54	26	50	9	62	25	1,683

a South Bosque not reported by months. b No record.

WELL RECORD IN COASTAL TEXAS.

The following tables give the well records in coastal Texas from 1906 to 1910, inclusive:

Number of wells completed in coastal Texas, 1906–1910, by districts.

District.	Completed.					Dry.					Oil.				
	1906	1907	1908	1909	1910	1906	1907	1908	1909	1910	1906	1907	1908	1909	1910
Batson	80	206	53	51	65	4	32	10	11	14	76	174	43	40	51
Dayton	7	18	8	4	.....	3	7	6	4	.....	4	11	2	0	.....
Goose Creek	.....	.....	5	7	3	.....	.....	3	2	2	.....	.....	2	5	1
Hoskins Mound a	6	3	8	2	4	5	3	6	1	2	1	.....	2	1	2
Humble	345	269	281	201	160	123	b 99	c 80	d 72	45	222	170	201	129	115
Markham	.....	.....	10	2	16	.....	.....	5	.....	7	.....	.....	5	2	9
Matagorda (Big Hill)	.....	6	.....	.....	.....	.....	5	.....	.....	.....	.....	1	.....	.....	.....
Mission	.....	7	5	.....	.....	.....	4	2	.....	.....	.....	3	3	.....	.....
Piedras Pintas	.....	4	.....	12	1	.....	.....	.....	10	.....	.....	4	.....	2	1
Saratoga	64	98	44	31	37	9	12	4	4	7	55	86	40	27	30
Sourlake	74	156	81	146	95	20	e 36	e 9	e 30	12	54	120	72	116	83
Spindletop	68	122	108	82	100	29	21	26	36	27	39	101	82	46	73
West Columbia f	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Total	644	889	603	538	481	193	219	151	170	116	451	670	452	368	365

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 Texas, 1906–1910, 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
1910	55	38	52	40	50	37	46	38	32	30	34	29	481

Number of dry holes drilled in coastal Texas, 1906–1910, 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
1910	14	16	9	11	20	11	11	10	7	1	3	3	116

Total and average initial daily production of new wells in coastal Texas, 1906–1910, by districts, in barrels.

District.	Total initial production.					Average initial production per well.				
	1906	1907	1908	1909	1910	1906	1907	1908	1909	1910
Batson	3,935	18,004	2,806	2,179	2,328	87.4	103.5	65.2	54	45.6
Dayton	200	730	90	....	....	100	66.3	45	....	....
Goose Creek	....	....	500	54	100	....	....	250	11	100
Hoskins Mound	....	....	....	20	4,500	....	....	....	20	2,250
Humble	5,560	30,643	46,260	8,645	7,502	79.4	180.2	230.1	67	65.2
Markham	....	....	2,700	175	22,100	....	....	540	87	2,455.5
Piedras Pintas	....	....	....	175	150	....	....	....	87	150
Saratoga	5,565	11,487	5,135	3,590	2,137	154.6	133.5	128.4	13.3	71.2
Sour Lake	5,570	12,481	7,376	12,737	16,388	192.1	104	102.4	11	197.4
Spindletop	2,275	10,452	9,385	5,725	8,078	94.8	103.5	114.4	12.4	110.7
Total	[a]23,105	83,797	74,252	33,300	63,283	112.1	126.6	166.1	89.7	173.5

[a] Six months.

Total initial daily production of new wells in coastal Texas, 1906–1910, by months, in barrels.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	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
1910	3,048	3,135	1,150	5,540	2,935	4,457	8,570	3,940	3,500	4,590	13,835	8,583	63,283

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 1910:

Quantity of petroleum shipped by railroad in tank cars from the oil fields of Texas, at the stations named, by months, during the year 1910, in barrels.

Month.	Beaumont, Guffey.	Corsicana.[a]	Danbury, Markham, Noledo, Christine.	Houston, Trice.	Humble.	Saratoga.	Sour Lake.	Total.
January	4,265	12,410	1,912	55,964	89,546	....	35,714	199,811
February	2,233	12,408	2,219	57,351	51,644	....	17,656	143,511
March	3,142	12,410	23,083	75.698	63,888	....	23,262	201,483
April	1,941	12,409	4,622	73,809	94,225	1,623	33,076	221,705
May	822	12,410	3,648	68,533	120,702	3,412	83,700	293,227
June	852	12,409	4,578	72,274	77,651	2,024	6,170	175,958
July	335	12,410	6,735	60,515	93,369	819	1,186	175,369
August	382	12,410	40,047	72,209	162,358	2,262	5,570	295,238
September	380	12,409	48,240	51,018	69,715	2,076	14,395	198,233
October	329	12,410	51,725	73,849	47,146	2,982	5,449	193,890
November	1,199	12,409	73,311	72,838	72,654	3,394	157	235,962
December	8,288	12,410	180,255	85,342	11,448	2,498	3,377	303,618
Total	24,168	148,914	440,375	819,400	954,346	21,090	229,712	2,638,005

[a] Averaged.

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 1910, by months, in gallons.

Month.	Crude.		Naphtha.		Illuminating.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
January	3,790,667	$114,982	28,591	$4,856	3,748,246	$165,257
February	2,584,230	59,359	998	147	4,299,614	205,175
March	809,989	19,050	2,320,220	162,575	5,298,993	239,008
April	842,140	19,911	2,387	287	4,384,913	198,202
May	7,490	292	2,038	311	4,455,334	201,407
June	53	5	4,986	657	2,150,493	97,455
July	933,134	22,230	3,626	536	4,455,017	211,934
August	1,051,786	38,648	32,225	5,246	4,877,625	273,479
September	....	....	2,118	301	4,426,947	199,339
October	2,609,174	50,722	2,910	417	7,643,785	411,388
November	2,170,270	67,387	14,231	2,252	6,507,768	303,292
December	1,664,638	27,744	3,715	430	9,443	1,165
Total	16,463,571	420,330	2,418,045	178,015	52,258,178	2,507,101

Month.	Lubricating and paraffin.		Residuum.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
January	89,664	$17,123	4,410,910	$151,601	12,068,078	$453,819
February	105,475	19,017	6,100,270	225,201	13,090,587	508,899
March	92,074	16,752	2,964,751	98,084	11,486,027	535,469
April	178,992	33,672	6,663,513	230,404	12,071,945	482,476
May	161,006	32,457	2,880,460	96,150	7,506,328	330,617
June	61,034	13,421	8,995,973	289,408	11,212,539	400,946
July	222,968	20,040	6,023,967	210,838	11,638,712	465,578
August	127,740	26,111	5,037,472	172,991	11,126,848	516,475
September	133,231	19,321	5,027,006	175,945	9,589,302	394,906
October	174,373	31,522	4,473,951	147,831	14,904,193	641,880
November	81,307	17,422	4,110,911	143,900	12,884,487	534,253
December	144,137	25,590	1,580,668	55,323	3,402,601	110,252
Total	1,572,001	272,448	58,269,852	1,997,676	130,981,647	5,375,570

Exports of crude and refined petroleum from Texas, by customs districts, in calendar year 1910, in gallons.

Customs district.	Crude, including all natural oils.		Naphtha.		Illuminating.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Corpus Christi	13,600	$320	6,435	$556	1,027	$281
Brazos de Santiago			729	99	6,199	795
Galveston	1,910,483	48,051	45	9	352	67
Sabine	14,527,965	371,495	2,381,616	173,283	52,166,055	2,495,826
Paso del Norte	11,523	464	22,219	3,111	32,354	3,683
Saluria			7,001	957	52,191	6,449
Total	16,463,571	420,330	2,418,045	178,015	52,258,178	2,507,101

Customs district.	Lubricating and heavy paraffin.		Residuum.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Corpus Christi	226,754	$33,204	89,859	$3,542	337,675	$37,903
Brazos de Santiago	155	59			7,083	953
Galveston	943,877	191,275			2,854,757	239,402
Sabine	332,889	30,852	58,179,993	1,994,134	127,588,518	5,065,590
Paso del Norte	15,005	6,097			81,101	13,355
Saluria	53,321	10,961			112,513	18,367
Total	1,572,001	272,448	58,269,852	1,997,676	130,981,647	5,375,570

LOUISIANA.

DEVELOPMENT.

In Louisiana three gushers were struck in the Vinton region, in the southwestern part of the State, each yielding 3,000 barrels or more a day. The decline in production in the southern part of the State was in marked contrast to the increase in the output of the Caddo field, in the northwestern corner of the State.

Just before the opening of 1910 the J. C. Trees Oil Co. carried well No. 4 to a depth below 2,300 feet, and it began to yield over 2,000 barrels a day before the bit had been removed. This well is in the Stiles tract, on the western edge of sec. 17, T. 21 N., R. 16 W., on the west side of James Bayou, which is on the western edge of the Caddo pool. The production of this well declined in a month to half its initial rate, then gradually increased to 3,000 barrels, and continued at a rate varying between 1,000 and 2,000 barrels a day. The Gulf Pipe Line Co. at once drilled on a large tract of its land 2½ miles southwest of the Trees well. In April the No. 1 Burr tract of this company came in at a depth of 2,225 feet, flowing 2,000 barrels a day. The oil from all these wells is light, Burr No. 1 showing 43.6° Baumé. It is rich in paraffin and contains no asphalt. The Producers' Oil Co. developed the territory between the Burr and the Stiles tracts, obtaining in sec. 27, T. 21 N., R. 16 W., a well giving a larger yield than either of those just mentioned. This was at once offset by a well (No. 9, Stiles tract) 95 feet farther west, which showed a greater yield than the Producers', but the output of each well was influenced by that of the other. Northeast of the No. 4 Trees a well showed salt water, and several dry holes were drilled farther northwest. Late in June the Producers' Oil Co. brought in well No. 6, in sec. 33, T. 21 N., R. 16 W., which yielded over 12,000 barrels a day. This well was struck by lightning on June 19, before it was finished, but the fire was extinguished in 48 hours. The wells in the James Bayou region range in depth from 2,207 feet to over 2,300 feet. Several other great wells have shown the large capacity of this pool. A table of these wells is given in Bulletin 429 of the United States Geological Survey. In October the Producers' Oil Co. drilled a test well in the southeast quarter of sec. 3, T. 16 N., R. 20 W., on the south side of James Bayou, a mile or more south of the proved area, and obtained over 5,000 barrels a day. This is a notable extension of the field. By drilling the No. 2 Hart tract well 5 feet deeper the Trees Oil Co. increased its yield from 1,000 to 6,000 barrels. Near the end of the year a well on the Isles Lane farm, on the other side of James Bayou from the Stiles tract, yielded 8,500 barrels a day. Three other events aided the development of this pool later in the year. The pipe line of the Standard Oil Co. was completed from Oklahoma to the refinery at Baton Rouge, La. It passes close to the Caddo field, and a lateral was promptly laid connecting the James Bayou pool, and plans begun for duplicating the line. In June the State legislature passed the necessary acts and provided for a vote by the people on the establishment of a system of protection against the waste of natural gas in the Caddo field. The resultant vote ratified these measures. In October, 1910, the Standard Oil Co. purchased over 100,000 acres of proved oil territory in the James Bayou region and has actively continued development work; other important acquisitions by lease were made by the Producers' Oil Co.; and the entire territory covered by Ferry Lake, about 8,000 acres, was leased by the Gulf Refining Co. from the State levee board.

The output of oil increased notably during the year, amounting to over 5,000,000 barrels, and requiring the construction of two additional pipe lines to Texas ports—one by the Gulf Co. to connect at Lufkin, Tex., with its main line to the Gulf; the other by the Texas Co., to Beaumont.

The price of light Caddo oil was lowered in July from 40 cents to 38 cents by increased production, but rose again to 40 cents in September and to 42 cents in November.

PRODUCTION.

The following table shows the production of petroleum in Louisiana in 1909 and 1910, by districts and months:

Production of petroleum in Louisiana in 1909 and 1910, by districts and months, in barrels.

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 of petroleum in Louisiana in 1909 and 1910, by districts and months, in barrels—Continued.

1910.

Month.	Jennings.	Welsh.	Anse la Butte.	Caddo.	Vinton.	Total.
January	127,058	4,528	277	121,629	....	253,492
February	128,013	4,525	462	150,674	....	283,674
March	145,877	4,528	4,064	212,770	....	367,239
April	116,564	4,528	1,235	262,211	....	384,538
May	125,477	4,528	619	406,058	....	536,682
June	120,306	4,528	5,351	587,523	....	717,708
July	170,849	4,724	3,185	481,344	....	660,102
August	148,619	4,724	13,027	354,355	....	520,725
September	130,133	4,528	5,395	771,744	....	911,800
October	158,287	4,528	2,479	764,123	....	929,417
November	118,426	4,527	6,067	501,866	6,908	637,794
December	135,550	4,528	1,857	476,496	19,793	638,224
Total	1,625,159	54,724	44,018	5,090,793	26,701	6,841,395

Production and value of petroleum in Louisiana in 1909 and 1910, by districts, in barrels.

District.	1909			1910		
	Quantity.	Value.	Price per barrel.	Quantity.	Value.	Price per barrel.
Jennings	1,966,614	$1,421,806	$0.723	1,625,159	$1,187,312	$0.731−
Welsh	26,169	19,882	.760	54,724	46,047	.841+
Anse la Butte	37,930	31,680	.835	44,018	35,010	.795
Caddo	1,028,818	549,081	.533	5,090,793	2,292,349	.450+
Vinton	....	....	....	26,701	13,351	.500
Total	3,059,531	2,022,449	.661	6,841,395	3,574,069	.522+

Production of petroleum in Louisiana, 1902–1910, by districts, in barrels.

Year.	Jennings.	Welsh.	Anse la Butte.	Caddo.	Vinton.	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
1910	1,625,159	54,724	44,018	5,090,793	26,701	6,841,395

PRICES.

In the following table are given the prices paid for petroleum at wells in Louisiana in the years 1908 to 1910, inclusive:

Average monthly price of petroleum per barrel at wells in Louisiana, 1908–1910, by districts.

Month.	Jennings.			Caddo.			Vinton.
	1908	1909	1910	1908	1909	1910	1910
January	$0.699–0.75	$0.60–0.70	$0.74–0.76	$0.725	$0.40	$0.59–0.60	....
February	.66 – .725	.60– .67	.74– .76	.735	.40	.59– .60	....
March	.67 – .792	.63– .72	.72– .77	.70	.40	.59– .60	....
April	.55 – .725	.72– .76	.75– .87	.675	$0.50–.52	.53– .60	....
May	.52 – .725	.70– .75	.75– .87	.635	.50–.55	.38– .56	....
June	.45 – .725	.70– .75	.75– .87	.635	.55–.57	.38– .44	....
July	.43 – .729	.70– .75	.70– .74	$0.35 –.465	.55–.60	.38– .42	....
August	.45 – .564	.75– .86	.70– .74	.30 –.35	.55–.60	.38– .42	....
September	.45 – .57	.75– .86	.70– .71	.315–.35	.60	.38– .40	....
October	.55 – .577	.75– .86	.65– .70	.31 –.40	.60	.40	....
November	.55 – .604	.75– .775	.67– .72	.37 –.40	.60	.40– .42	....
December	.55 – .693	.75– .775	.67– .73	.37 –.40	.60	.42– .42½	....
Average	.618	.723	.731	.428	.533	.450+	$0.50

WELL RECORD.

In the following tables are given the well records for Louisiana for the years 1906 to 1910, inclusive:

Number of wells completed in Louisiana, 1906–1910, by districts.

District.	Completed.					Dry.					Oil.				
	1906	1907	1908	1909	1910	1906	1907	1908	1909	1910	1906	1907	1908	1909	1910
Jennings	71	76	142	51	22	23	23	38	23	6	48	53	104	28	16
Welsh	2	1	.....	2	5	.....	.....	.....	1	.....	2	1	.....	1	5
Anse la Butte	10	4	16	9	4	5	2	9	4	1	5	2	7	5	3
Caddo	2	23	58	121	a226	1	b15	c15	d52	e102	1	8	43	69	124
Vinton	.....	.....	.....	.....	11	.....	.....	.....	.....	3	.....	.....	.....	.....	8
Total	85	104	216	183	268	29	40	62	80	e112	56	64	154	103	156

a Includes Marion County, Tex.
b Includes 11 gas wells.
c Includes 6 gas wells.
d Includes 19 gas wells.
e Includes 48 gas wells.

Number of wells completed in Louisiana, 1906–1910, 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
1910	16	14	22	24	18	22	21	33	26	15	25	32	268

Number of dry holes drilled in Louisiana, 1906–1910, 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
1910	9	10	14	19	6	6	1	14	9	......	9	15	a112

a Includes 48 gas wells.

Total and average initial daily production of new wells in Louisiana, 1906–1910, by districts, in barrels.

District.	Total initial production.					Average initial production per well.				
	1906	1907	1908	1909	1910	1906	1907	1908	1909	1910
Jennings	12,550	43,270	84,620	11,745	3,230	261.5	816.4	813.6	419.0	201.9
Welsh	50	75	....	....	165	25.0	75.0	....	....	33.0
Anse la Butte	....	3,040	5,200	955	735	....	1,520.0	742.8	191.0	245.0
Caddo	....	975	14,355	8,750	[a]139,945	....	121.9	333.8	127.0	1,128.6
Vinton	....	....	....	....	11,100	....	....	....	....	1,387.5
Total	12,600	47,360	104,175	21,450	155,175	252.0	740.0	676.4	210.3	994.7

[a] Includes Marion County, Tex.

Total initial daily production of new wells in Louisiana, 1906–1910, 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
1910	1,750	1,345	5,320	3,520	11,040	20,650	8,270	12,245	33,560	30,840	16,215	10,420	155,175

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 1910, by months:

Rail shipments of petroleum from stations on the lines of the Louisiana Western Railroad and Kansas City Southern Railway in Louisiana in 1910, in barrels.

Month.	Anse la Butte.	Caddo oil.				Jennings oil.				Vinton.	Total.
		Lewis.	Mooringsport.	Oil City.	Vivian.	Egan.	Jennings.	Lake Charles.	Mermentau.		
January	155	....	39,098	72,600	16,798	3,869	59,500	....	5,182	......	197,202
February	462	....	16,185	119,077	10,811	3,405	61,528	7,524	4,140	......	223,132
March	3,250	....	19,044	108,275	....	7,893	48,792	4,988	2,110	......	194,352
April	1,235	....	63,870	118,726	....	8,035	15,775	25,066	25,759	......	258,466
May	619	34,947	63,024	208,136	....	9,750	56,173	25,859	29,143	......	427,651
June	5,351	145,416	77,352	297,353	....	10,986	33,341	3,457	58,237	......	631,493
July	3,185	130,437	45,774	153,384	29,488	2,631	32,746	440	65,045	......	463,130
August	13,027	70,341	48,676	123,103	45,115	9,286	18,024	193	83,595	......	411,360
September	5,395	211,326	451	170,540	45,463	3,821	12,130	192	86,026	......	535,344
October	2,479	232,393	171	141,693	50,764	4,486	29,205	....	33,130	......	494,321
November	6,067	181,361	192	115,153	46,876	10,749	30,563	....	58,996	10,652	460,609
December	1,857	237,781	190	67,914	51,757	6,912	19,450	....	63,388	4,998	454,247
Total	43,082	1,244,002	374,027	1,695,954	297,072	81,823	417,227	67,719	514,751	15,650	4,751,307

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.

DEVELOPMENT.

Production in California increased from 55,471,601 barrels in 1909 to 73,010,560 barrels in 1910, a gain during the year of 17,538,959 barrels, or 31 62 per cent. Stocks increased to a total of 33,088,118 barrels. The production given for 1910 does not include 4,156,450 barrels of oil held in storage by the producers, but which had not been sold or delivered to transportation agencies. About half of this was produced in 1909 and half in 1910. A considerable part of the 1910 portion was held in the reservoir of the Lakeview Co.'s well.

The vital result of this great gain in production was to convince the general public of the conservatism of the estimate made by Mr. Ralph Arnold for the United States Geological Survey that the known oil fields of the State can furnish a minimum of 5,000,000,000 barrels and a probable maximum of 8,000,000,000 barrels of oil. In other words, a supply of cheap and most efficient fuel is available in California for a century to come, with corresponding assurance of proper development of the State in manufacturing.

Of principal interest was the development on the west side of the San Joaquin Valley, details of which follow.

SUNSET-MIDWAY DISTRICT.

The Santa Fe Co. began the year 1910 by bringing in a well in the North Midway field which flowed 2,000 barrels a day. Soon afterwards the St. Lawrence well, in the adjoining section, proved about as good, although sanding a great deal. On February 7 a well was finished in sec. 30, T. 32 S., R. 24 E., which began flowing 800 barrels a day. The flow increased steadily until by the middle of March the well yielded, by measurement, over 9,000 barrels a day. Early in March the Mays well was brought in on sec. 30, T. 31 S., R. 23 E., in new territory some miles northwest of the previous gusher.

On March 15 the Lakeview Oil Co.'s well, a controlling interest in which had been turned over to the Union Oil Co., was drilled to 2,230 feet and began flowing at a rate estimated at about 10,000 barrels a day. This increased rapidly to about 30,000 barrels. It was impossible at first to control the well, which soon destroyed the derrick and enlarged the size of the hole. Finally the well was surrounded by bags of sand, and the oil was led by pipes and ditches to storage reservoirs, which were soon filled. The flow was surprisingly persistent, and as months went by the oil seemed to clear itself of sand and increased its daily product to over 40,000 barrels. It began to decline in the later part of the summer, and by the end of the year had fallen to less than 10,000 barrels a day; the proportion of water had increased from less than 1 per cent to about 56 per cent late in December. In this time the well had produced about 5,000,000 barrels of oil that was saved. The oil is of somewhat lighter gravity than the average for the district.

This phenomenal strike was followed promptly by greatly increased activity, although drilling had to be suspended in the immediate vicinity, owing to the danger of fire. The region became the focus of oil interest in the United States. The financial effect of this strike was to reduce the price of oil not already contracted for until 30 cents a barrel was offered; but with rapidly increasing capacity the tendency to keep oil in storage for better prices led to compromises and concessions to the allied producers, especially after the completion of the new independent pipe line to the coast. The Associated Oil Co. built an 8-inch pipe line from Sunset to its line at Coalinga, and the Standard Oil Co. duplicated its 6-inch line from the Sunset-Midway field to Kern Run, connecting with the main line to Point Richmond.

The Pioneer Midway well, struck in April in sec. 30, T. 31 S., R. 24 E., proved another exceptional find.

The Honolulu Oil Co. struck a large gas well to the east of the oil field, in the Buena Vista Hills. The Standard Oil Co. also struck a gas well on the western edge of the Buena Vista Hills, in sec. 10, T. 32 S., R. 24 E., and the gas proved to have a pressure so great that it could not be confined, although part has been piped away for industrial use under boilers and for lighting in the neighborhood. The flow has been sufficient to justify piping the gas to Bakersfield and other near-by points. These wells have started what promises to be a great gas industry in California.

COALINGA DISTRICT.

In the Coalinga district development work proceeded most satisfactorily, the oil being found deeper down the dip of the strata, as had been predicted, and the area of the developed field being thus considerably enlarged.

An important addition to the proved oil territory resulted from the discovery of light oil in the Azores and Bohemian wells on the Jacalitos anticline, several miles south of the nearest producing wells. This area had been classified as oil land in Bulletin 398 of the United States Geological Survey, and the depth of the oil sand where it approaches nearest to the surface was estimated as 3,600 feet. The discovery was made at exactly this depth.

Operations were actively pushed in the Kettleman Hills during the year. As yet no oil has been discovered in these hills, but the geologic conditions are favorable, and a strip 27 miles long and nearly 2 miles wide along their summit is classified as oil land in Bulletin 398 of the Survey.

VALLECITOS DISTRICT.

A region farther north, the Vallecitos district, along the west side of the San Joaquin Valley and over 20 miles from the nearest wells of the Coalinga field, is beginning to attract some attention as a possible future field. During the fall of 1910 the United States Geological Survey published a preliminary statement on this region and reported favorably on some areas within it. In at least one of these areas a test well has been started.

LOST HILLS DISTRICT.

One of the most important discoveries of the year was in the Lost Hills, where oil was struck in October by the Lakeshore well, the first well ever drilled there, at a depth of less than 600 feet. This strike caused a rush of prospectors to the locality and the beginning of operations on a large scale. The Lost Hills had been reported in Bulletins 398 and 406 of the United States Geological Survey as probably oil bearing, and a large area of public land in them had been withdrawn. The shallowness of the oil was a surprise, however, and tended to indicate that even a larger area would be oil bearing. Hence further withdrawals of possible oil lands belonging to the public were made.

SANTA MARIA AND LOS ANGELES DISTRICTS.

Developments in the Santa Maria fields were satisfactory, especially to the east in Cat Canyon, where work would have been more extended but for the investment by the local capitalists in the new strikes in the Sunset Midway field.

The development in the Los Angeles pools was uneventful.[1]

GUSHERS DRILLED IN 1910.

A list of the principal gushers drilled during the year is given in the following table:

Principal gushers drilled in California in 1910.

Date.	Name.	Location.	Depth.	Initial daily production.	Remarks.
	Sunset-Midway field.		*Feet.*	*Barrels.*	
Jan. —	Santa Fe Co	North Midway		2,000	Sanded a great deal.
Feb. 7	St. Lawrence Standard Oil Co.	Sec. 30, T. 32, R. 24	3,000	800	Flow increased to 9,000 barrels the middle of March.
Mar. 4	Mays well	Sec. 30, T. 31, R. 23	2,700	30,000	New territory.
Mar. 15	Lakeview	Sec. 25, T. 12, R. 24	2,230	10,000	Increased to 40,000 barrels; July 20, had declined to 31,000 barrels; July 30, 22,000 barrels, 3 per cent water; Aug. 20, 20,000 barrels, 7 per cent water; December, less than 10,000 barrels, about 56 per cent water.
Apr. 3	Pioneer-Midway	Sec. 30, T. 31, R. 24	2,750	20,000	Broke loose about May 15.
May 20	American Oilfields (Ltd.).	Sec. 31, T. 32, R. 24	2,400	5,000	
Do	Honolulu Oil Co	Sec. 10, T. 32, R. 24	2,700		Produced about 100 barrels daily after it settled down. First discovery of oil in Buena Vista Hills.
Do	Standard Oil Co	Sec. 26, T. 31, R. 23	2,370		Gas well, 15,000,000 cubic feet daily. Shut off gas and drilled deeper for oil.
May 25	Union Oil Co	Sec. 14, T. 32, R. 23	2,580	25,000	5 miles northwest of Lakeview; sanded in 2 days.
Do	American Oilfields (Ltd.).	Sec. 36, T. 31, R. 22	985	4,700	Steady.
Do	Eagle Creek Oil Co. No. 3.	Sec. 31, T. 32, R. 23, North Midway.	1,552	10,000	200 feet from Santa Fe gusher.
June —	Essex Oil Co. No. 1	Sec. 36, T. 11, R. 23, Midway.		5,000	
June 22	Pacific Midway	Sec. 32, T. 12, R. 23, Sunset.		5,000	
July 5	Midway Consolidated	Sec. 30, T. 12, R. 23		15,000	
July 10	Maricopa No. 36	Sec. 36, T. 12, R. 24		15,000	
July 22	Santa Fe	North line of SE. ¼ sec. 36, T. 35, R. 22.	1,700	20,000	Sanded.
July 24	American Oilfields (Ltd.) No. 79.	Sec. 36, T. 31, R. 22	1,085	30,000	Choked soon. In August, flow increased to 24,000 barrels. No. 68 started at 1,000 and later broke loose at 8,000 barrels.
Aug. 7	Union Oil Co			30,000	Sanded after a few hours.
Aug. 10	Sunset-Monarch	Sec. 36, T. 12, R. 24	2,270	15,000	
Do	Visalia-Midway	Sec. 28, T. 31, R. 22	2,000	1,200	
Sept. 10	Western Minerals Co	Sec. 22, T. 11, R. 23	1,340	50 to 100	3 miles east of any other production. Light oil.
Sept. 23	Sunset-Monarch	Sec. 26, T. 12, R. 24	2,200	25,000	½ mile west of Lakeview. Flow decreased to 1,000 barrels when gate valve was put on.
Sept. 24	Olig Oil Co	Sec. 32, T. 31, R. 23	2,700		

[1] The California oil resources were described in a private pamphlet by M. L. Requa, mining engineer.

Principal gushers drilled in California in 1910—Continued.

Date.	Name.	Location.	Depth.	Initial daily production.	Remarks.
	Sunset-Midway field—Continued.		*Feet.*	*Barrels.*	
Oct. 29	Honolulu Oil Co	Sec. 6, T. 32, R. 24			Gas well, reported 1,000 pounds pressure and 40,000,000 to 50,000,000 cubic feet a day; was killed by injecting heavy mud in order to drill deeper.
Nov. 11	Midway Five Oil Co	Sec. 5, T. 32, R. 23, North Midway.	2,250	24,000	Choked with sand; broke loose late in month at 1,000 barrels an hour and settled to 3,000 barrels a day.
Nov. 13	Midway-Premier Oil Co.	do	2,100	30,000	Spouting 8,000 barrels in middle of December and 2,500 barrels at the close of the year.
Nov. 30	Union Oil Co. No. 9	Sage tract, 400 feet south of Lakeview.	2,160		Sanded.
Do	Union Oil Co. No. 11	West of Lakeview	1,965		Sanded after a few hours' flow.
Do	Maricopa Thirty-six Co. No. 2.	Southeast of Lakeview.	1,970		Sanded after two days' flow.
Dec. 20	Midway Northern	Sec. 32, T. 12, R. 23			Sanded up after a few hours.
	Coalinga field.				
June 28	American Petroleum Co. No. 9.	Sec. 30, T. 20, R. 15		10,000	
	Santa Maria field.				
May 18	Palmer Oil Co. No. 2	Cat Canyon	2,900	4,000	Broke loose July 20 and flowed at the rate of 8,000 barrels per day.
Sept. 1	Palmer Oil Co. No. 2	do		6,000	
Do	Dome Oil Co. No. 1	do		1,400	Great gas pressure.
Oct. 25	Palmer Oil Co. No. 3	do		6,000	

LAWS AFFECTING OIL LANDS.

The meeting of the American Mining Congress in Los Angeles in September, 1910, brought out much discussion of the policy of the Federal Government as to the withdrawals of oil lands and the proposed policy of leasing the public oil lands. A committee was sent to Washington to endeavor to have the application of the Yard decision remedied and to seek some prompt adjustment of the petroleum laws. The result was successful in settling this chief legislative burden of the oilmen after a careful investigation of the situation on the ground by Frank Pierce, Assistant Secretary of the Interior, and George Otis Smith, Director of the Geological Survey.

DURATION OF CALIFORNIA PETROLEUM RESOURCES.

The following memorandum on the subject of duration of California petroleum resources was prepared by Director George Otis Smith for the Secretary of the Interior:

On the subject of the period of possible domination of the Pacific fuel market by California oil, no more authoritative data are available than the discussion of the subject by Arnold and Day of this Survey in 1909, and by M. L. Requa, a California mining engineer, in 1910 and 1911. I will therefore practically confine myself to the summary of these statements, which are found in the Conservation Commission report by Dr. Day, reprinted in United States Geological Survey Bulletin 394, and in an address by Mr. Requa before the Mining Association, University of California (privately printed), and in another address before the San Francisco meeting of the American Institute of Mining Engineers (not yet published).

The importance of the California field is seen from the statement by Day, quoted by Requa, that this one State is to be credited with one-tenth of the total area of oil land in the United States, with over one-third the present production, and also with a total quantity of oil equal to one-half of the minimum and one-third of the maximum estimated resources of the whole United States. These minimum and maximum estimates by the United States Geological Survey for California are 5,000,000,000 barrels and 8,500,000,000 barrels, respectively, and Mr. Requa believes "the maximum will be unquestionably in excess of 8,500,000,000 barrels for California." Apparently he arrives at this conclusion by computing for the productive territory of 850 square miles, or more than 500,000 acres (Survey estimate), a productivity equal to that of the territory already producing, which calculation yields an estimated "total possible recovery of 11,000,000,000 barrels, with possibilities even beyond this quantity."

Mr. W. W. Orcutt, the geologist of the Union Oil Co., figuring from the areas from which there is present production, estimates the total quantity at 3,750,000,000 barrels. This estimate may be considered a minimum corresponding to Mr. Requa's maximum of 11,000,000,000 barrels, in which case the mean of 7,380,000,000 barrels is approximately the same as that for the Survey estimates of 5,000,000,000 barrels and 8,500,000,000 barrels.

The total production from 1875 to September, 1911, is given by Requa as approximately 434,000,000 barrels, leaving, say, 7,000,000,000 underground. The 1910 production was 73,010,560 barrels, and for the first six months of 1911 was 38,000,000 barrels (Requa) or approximately the same as for 1910. Consumption has lagged behind production since 1909, when both were 58,000,000 barrels. In the first eight months of 1911 the actual consumption is given by Requa as at the rate of less than 64,500,000 barrels. This makes it improbable that consumption and production will continue to increase at the rate of increase that held for the few years prior to 1910.

Possible expansion of the market for California fuel oil must come from its adaptation to domestic use now apparently possible, the equipment of locomotives with oil burners—1910 alone showed an increase of 23 per cent over the previous year's consumption for this purpose—the increasing adoption of oil for the larger steamers, and the opening of the eastern coast of both North America and South America by the Panama Canal. These increases can hardly be estimated, and, moreover, there are other factors to offset them, such as the possible piping of California gas for domestic and other uses within the populous portions of the State which are easily accessible to the oil and gas fields, and the competition from Mexican oil on both the eastern and the western coast of South America. One factor which has not been given sufficient weight is that of increasing population of the Pacific States and of growth in manufacturing and industrial development, which has been long delayed, but on the other hand the possibility of the discovery of new fields in California may not have been given full allowance.

With the market possibilities as now seen, I am inclined to agree with the belief of Mr. Requa that 100,000,000 barrels may be the ultimate maximum annual consumption, and that a market for this amount of California oil will be found within five years. This brings us to the question of duration of the supply. At this rate of consumption, which, it will be noticed, is over 50 per cent in excess of the present rate, the life of the California field may be estimated as follows: At about 37 years, according to Mr. Orcutt's minimum estimate for California's petroleum resources—his own estimate of life being 50 years at an annual rate of 75,000,000 barrels; at from 45 to 80 years on the basis of the Survey estimates of quantity; and at over a century on Mr. Requa's own maximum estimate. Of course the production will not keep up to the maximum during the whole life of the field, but during the later decades will be in amounts unequal to the industrial demands.

Mr. Requa's latest word is that he believes the assertion warranted "that California oil will dominate the fuel market of the Pacific, at least through the present century." Although this statement may represent the extreme of optimism, I would hesitate to discount his estimate more than a third.

PRODUCTION.

The following table shows the production and value of petroleum in California in 1909 and 1910, by districts and counties:

Production and value of petroleum in California in 1909 and 1910, by districts and counties, in barrels.

District.	1909			1910		
	Quantity.	Value.	Price per barrel.	Quantity.	Value.	Price per barrel.
Coastal and southern:						
Los Angeles County—						
Los Angeles city	476,483	$330,139	$0.693	441,639	$305,334	$0.691
Newhall						
Puente						
Salt Lake-Sherman						
Whittier						
Orange County—						
Brea Canyon						
Fullerton	16,218,108	9,321,563	.575	16,152,528	10,143,829	.628
Ventura County—						
Santa Paula						
Santa Barbara County—						
Lompoc						
Santa Maria						
Summerland	79,604	47,068	.591	71,511	44,742	.626
San Luis Obispo County						
San Mateo County	70,179	38,846	.554	[a] 60,405	38,175	.632
Santa Clara County						
San Joaquin Valley:						
Fresno County—						
Coalinga	14,795,459	8,482,088	.573	18,387,750	9,143,358	.497
Kern County—						
Kern River	14,946,784	7,723,172	.517	14,698,907	6,060,159	.412
McKittrick	5,077,362	2,902,790	.572	5,664,653	2,140,070	.382
Midway	2,094,851	1,066,319	.509	10,436,137	5,122,375	.491
Sunset	1,712,771	844,728	.493	7,157,030	2,751,431	.384
Total	23,831,768	12,537,009	.526	37,896,727	16,074,035	.424
Grand total	55,471,601	30,756,713	.554	73,010,560	35,749,473	.490

[a] No production in San Mateo County in 1910.

The following table shows the production of petroleum in California, by counties, from 1901 to 1910, inclusive:

Production of petroleum in California, 1901–1910, by counties, in barrels.

Year.	Fresno.	Kern.	Los Angeles.	Orange.	Santa Barbara.	Ventura.	San Mateo.	Santa Clara.	Total.
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	379,041	[a] 88,741		44,854,737
1909	14,795,459	23,831,768	16,774,195				[a] 70,179		55,471,601
1910	18,387,750	37,896,727	16,665,678				[b] 60,405		73,010,560

[a] Includes oil produced in San Luis Obispo County.
[b] Production of Santa Clara and San Luis Obispo counties.

Production of petroleum in California in 1909 and 1910, by districts and counties, with increase or decrease, in barrels.

District.	1909	1910	Increase.		Decrease.	
			Quantity.	Per cent.	Quantity.	Per cent.
Coastal and southern:						
Los Angeles County—						
Los Angeles city	476,483	441,639			34,844	7.31
Newhall; Puente; Salt Lake-Sherman; Whittier; Orange County—Brea Canyon, Fullerton; Ventura County—Santa Paula; Santa Barbara County—Lompoc, Santa Maria	16,218,108	16,152,528			65,580	.40
Summerland	79,604	71,511			8,093	10.17
San Luis Obispo County; San Mateo County; Santa Clara County	70,179	a 60,405			9,774	13.93
San Joaquin Valley:						
Fresno County—						
Coalinga	14,795,459	18,387,750	3,592,291	24.28		
Kern County—						
Kern River	14,946,784	14,698,907			247,877	1.66
McKittrick	5,077,362	5,604,653	527,291	10.39		
Midway	2,094,851	10,436,137	8,341,286	398.18		
Sunset	1,712,771	7,157,030	5,444,259	317.86		
Total	23,831,768	37,896,727	14,064,959	59.02		
Grand total	55,471,601	73,010,560	17,538,959	31.62		

a No production in San Mateo County in 1910.

FIELD REPORT.

The field report for California for 1909 and 1910 is shown in the following table:

Field report for California in 1909 and 1910, by counties and districts.

1909.

County and district.	Wells.						Acreage.			
	Productive Jan. 1.	Completed in 1909.		Abandoned.	Productive Dec. 31.	Drilling Dec. 31.	Locations.	Fee.	Lease.	Total.
		Oil.	Dry.							
Fresno County	515	135	11	6	644	88	23,982	23,521	47,129	94,632
Kern County:										
Kern River	1,216	199		22	1,393	25	160	7,492	6,717	14,369
McKittrick	160	51	18	3	208	6	840	6,399	17,566	24,805
Midway	77	131	9		208	25	1,320	10,238	17,897	29,455
Sunset	135	57	9	2	190	20	8,480	6,088	18,342	32,910
Devils Den; Lost Hills		1			1	3	160	320	2,280	2,760
Los Angeles County:										
Los Angeles city	459	1		9	451			77	61	a 138
Newhall-Puente	131	2		2	131	2		6,540	4,174	10,714
Salt Lake-Sherman	200	52	1	6	246	8		11,233	14,030	25,263
Whittier	119	6		1	124			4,735	94	4,829
Orange County	225	21	4	4	242	12		12,576	4,614	17,190
San Luis Obispo County	12	1	2		13	4		6,477	12,002	18,479
San Mateo County	4				4	2			600	600
Santa Clara County	4		3		4	1			6,680	6,680
Santa Barbara County:										
Lompoc-Santa Maria	188	36	10	4	220	30		48,751	150,035	198,786
Summerland	127			3	124			16	31	47
Ventura County	242	9	3	9	242	18		10,090	94,289	104,379
Miscellaneous	2				2					
Total	3,816	702	70	71	4,447	244	34,942	154,553	396,541	586,036

a Acreage in town lots.

Field report for California in 1909 and 1910, by counties and districts—Continued.

1910.

County and district.	Wells.						Acreage.			
	Productive Jan. 1.	Completed in 1910.		Abandoned.	Productive Dec. 31.	Drilling Dec. 31.	Locations.	Fee.	Lease.	Total.
		Oil.	Dry.							
Fresno County	644	161	8	11	794	148	19,632	24,986	50,297	94,915
Kern County:										
Kern River	1,393	206	5	8	1,591	22	....	8,168	6,796	14,964
McKittrick	208	25	10	2	231	15	840	5,991	17,641	24,472
Midway	208	212	4	12	408	230	3,020	22,798	29,432	55,250
Sunset	190	57	2	4	243	67	15,100	21,254	1,932	38,286
Devils Den / Lost Hills	1	1	......	....	2	7	2,760	1,120	....	3,880
Los Angeles County:										
Los Angeles city	451	......	......	24	427	1	....	77	61	[a] 138
Newhall-Puente	131	5	2	1	135	11	73	6,449	4,433	10,955
Salt Lake-Sherman	246	38	7	8	276	20	3,520	10,291	3,891	17,702
Whittier	124	......	1	3	121	6	....	5,099	148	5,247
Orange County	242	13	1	....	255	36	....	10,788	4,838	15,626
San Luis Obispo County	13	2	2	4	11	8	1,800	6,959	11,893	20,652
San Mateo County	4	......	......	....	4	1	....	....	600	600
Santa Clara County	4	1	......	....	5	2	....	153	6,000	6,153
Santa Barbara County:										
Lompoc-Santa Maria	220	22	4	1	241	45	4,438	28,027	153,718	186,183
Summerland	124	......	......	4	120	....	....	16	22	38
Ventura County	242	20	4	1	261	32	19,011	10,136	92,483	121,630
Miscellaneous	2	......	......	....	2	10	....	....	....	....
Total	4,447	763	50	83	5,127	661	70,194	162,312	384,185	616,691

[a] Acreage in town lots.

Production and value of petroleum in California, 1906–1910, by districts, in barrels.

Year.	Coastal and southern.		San Joaquin Valley.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1906	10,586,705	$4,362,370	22,511,893	$5,191,060	33,098,598	$9,553,430
1907	15,224,496	7,306,920	24,523,879	7,393,036	39,748,375	14,699,956
1908	16,335,676	9,296,743	28,519,061	14,136,759	44,854,737	23,433,502
1909	16,844,374	9,737,616	38,627,227	21,019,097	55,471,601	30,756,713
1910	16,726,083	10,532,080	56,284,477	25,217,393	73,010,560	35,749,473

COLORADO.

PRODUCTION.

No new oil fields were discovered in Colorado in 1910. The most productive fields of the State are those of Boulder and Fremont counties, where a very fine grade of oil is produced which is used for refining. In Garfield County, not far from Vernal, Utah, is produced annually a small quantity of petroleum, which is used for lubrication and for the manufacture of paint. Considerable development work has been in progress in Rio Blanco County, resulting in the completion of 21 wells at the close of 1910. Only sufficient petroleum was pumped from the wells in 1910 to furnish fuel necessary for drilling other wells, there being no transportation or market for the product.

The report shows that the petroleum production of Colorado in 1910 amounted to 239,794 barrels, as compared with 310,861 barrels in 1909, a decrease of 71,067 barrels, or 22.86 per cent.

In the following table is given the production of petroleum in Colorado, by fields and months, in 1909 and 1910:

Production of petroleum in Colorado in 1909 and 1910, by fields and months, in barrels.

Month.	1909			1910			
	Boulder.	Florence.	Total.	Boulder.	Florence.	Other.[a]	Total.
January	9,507	23,279	32,786	2,032	15,394	340	17,766
February	8,037	23,081	31,118	3,102	12,916	386	16,404
March	7,370	21,644	29,014	5,212	18,332	340	23,884
April	6,986	18,497	25,483	4,826	20,260	340	25,426
May	7,302	17,853	25,155	3,645	17,622	340	21,607
June	6,689	17,688	24,377	3,586	14,669	340	18,595
July	5,635	18,291	23,926	3,646	16,257	340	20,243
August	5,513	18,099	23,612	2,795	16,501	340	19,636
September	12,189	16,544	28,733	2,527	14,997	340	17,864
October	7,319	16,595	23,914	3,966	15,535	340	19,841
November	5,680	16,381	22,061	3,031	14,922	340	18,293
December	3,482	17,110	20,592	3,818	16,077	340	20,235
Total	85,709	225,062	310,861	42,186	193,482	4,126	239,794

a Averaged.

In the following table will be found the production and value of petroleum in the Boulder and Florence fields in Colorado from 1901 to 1910, inclusive:

Production and value of petroleum in Colorado, 1901–1910, by districts, in barrels.

Year.	Boulder.		Florence.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
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	a 310,861	318,162
1910	42,186	63,420	193,482	174,332	b 239,794	243,402

a Includes a small production in Garfield County.
b Includes production of Garfield and Rio Blanco counties.

FIELD REPORT.

The field report for Colorado for the year 1910 is shown in the following table:

Field report for Colorado in 1910, by counties.

County.	Wells.						Acreage.		
	Productive Jan. 1.	Completed in 1910.		Abandoned.	Productive Dec. 31.	Drilling, Dec. 31.	Fee.	Lease.	Total.
		Oil.	Dry.						
Boulder	24	2	1	2	24	3	2,789	2,020	4,809
Fremont	52				52		4,306	21,932	26,238
Rio Blanco	31	4			35	4	4,480	43,200	47,680
Other	1				1	1		40	40
Total	108	6	1	2	112	8	11,575	67,192	78,767

WYOMING.

PRODUCTION.

Crude petroleum has been produced in Wyoming for many years, but operations in 1910 assumed an importance worthy of note and promise greater returns in the future. The petroleum production in 1910 amounted to 115,430 barrels, by far the largest ever reported. This petroleum was produced from wells in Bighorn, Crook, Fremont, Natrona, and Uinta counties. The petroleum produced in Bighorn County is of paraffin base and 43° gravity and, except that used for fuel in the field, is shipped for refining to the Northwestern Oil Refining Co. at Cowley. A small quantity of petroleum produced in Crook County was used for lubrication and the manufacture of roofing paint. In Fremont County the Wyopo Co., operating in the Dallas oil field, has completed a pipe line 9 miles in length, extending from the oil field to a loading rack at Wyopo station on the Chicago and North Western Railway, from which point shipments are made. The petroleum is used for fuel, the railroad company being the chief consumer. Considerable development work has been done on lands located in Natrona County. So far as reported the petroleum produced from wells in this field in 1910 was used exclusively for drilling operations in the field. In the Spring Valley oil field of Uinta County is produced a very fine grade of oil which is refined by the Pittsburg-Salt Lake Oil Co.

Production of petroleum in Wyoming, 1901–1910, in barrels.

Year.	Quantity.	Year.	Quantity.
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] 20,056
1905	8,454	1910	[b] 115,430

[a] Estimated. [b] Includes the production of Utah.

FIELD REPORT.

The field report for Wyoming in 1910 is shown in the following table:

Field report for Wyoming in 1910, by counties.

County.	Wells.						Acreage.			
	Productive Jan. 1.	Completed in 1910.		Abandoned.	Productive Dec. 31.	Drilling, Dec. 31.	Locations.	Fee.	Lease.	Total.
		Oil.	Dry.							
Bighorn	16	6	8	....	22	4	....	1,380	48,530	49,910
Converse	6	......	......	....	6	....	....	500	2,400	2,900
Crook	7	2	......	....	9	1	1,240	640	....	1,880
Fremont	28	14	6	3	39	3	....	520	11,000	11,520
Johnson	1	......	......	....	1	....	....	160	....	160
Natrona	32	20	1	....	52	2	....	480	108,300	108,780
Uinta	17	5	......	2	20	7	14,000	6,340	6,200	26,540
Weston	....	......	......	....	....	1	....	....	....	....
Total	107	47	15	5	149	18	15,240	10,020	176,430	201,690

UTAH.

DEVELOPMENT.

Prospecting for oil has been carried on in five counties of Utah—Emery, Juab, San Juan, San Pete, and Washington. The only production reported in 1910 was from the San Juan field, where about seven wells have been drilled, which range from 300 to 680 feet in depth and would produce oil if put in commission. However, but two wells were operated in 1910, pumping only sufficient oil to supply fuel to operators in the field. One of these wells was pumped with a gasoline engine which uses the crude oil for fuel as it comes from the well. It is believed that this well, which is 600 feet deep, is capable of producing 250 barrels of petroleum daily. One well drilling in this field has reached a depth of 1,540 feet and a strike of oil is reported. The character of the oil is high-grade paraffin oil, 38° to 40° gravity. This oil field is known as the Goodridge basin and is located in southeastern Utah, 125 miles from a railroad, Dolores, Colo., being the nearest railroad station.

In the Washington County or Virgin River oil field, six productive wells have been drilled, but no production was reported for 1910. The wells in this field range from 540 to 682 feet in depth.

The statistics of production of petroleum in Utah are included with Wyoming.

FIELD REPORT.

The field report for Utah in 1910 is shown in the following table:

Field report for Utah in 1910, by counties.

County.	Wells.						Acreage.			
	Productive Jan. 1.	Completed in 1910.		Abandoned.	Productive Dec. 31.	Drilling Dec. 31.	Oil locations.	Fee.	Lease.	Total.
		Oil.	Dry.							
San Pete	2	......	......	....	2	....	200	....	....	200
San Juan	9	......	......	....	9	15	....	7,930	520	8,450
Washington	6	......	......	....	6	1	....	1,780	....	1,780
Total	17	......	......	....	17	16	200	9,710	520	10,430

MISSOURI.

PRODUCTION AND DEVELOPMENT.

A small production continues to be made in Missouri, as is shown in the following table:

Production of petroleum in Missouri, 1901–1910, in barrels.

Year.	Quantity.	Year.	Quantity.
1901	[a] 2,335	1906	[b] 3,500
1902	[b] 757	1907	[b] 4,000
1903	[b] 3,000	1908	[b] 15,246
1904	[b] 2,572	1909	[b] 5,750
1905	[b] 3,100	1910	[b] 3,615

[a] Includes the production of Michigan and a small production in Oklahoma.
[b] Includes the production of Michigan.

The recent efforts to obtain a larger supply of oil in the State are described below by Dr. H. A. Buehler, State geologist:

RECENT DEVELOPMENTS OF OIL AND GAS IN MISSOURI.

By H. A. Buehler.

There has been no material increase in the production of oil and gas in Missouri during the last three years, although a number of wells have been drilled throughout the State during this period. The shallow wells near Belton, Cass County, continue to produce a small quantity of oil and gas and similar wells, located near Holt and Lathrop, in Clay and Clinton counties, are capable of producing some gas. However, water has entered the sand, and there is no production from these wells at the present time.

The area, underlain by the Pennsylvanian, is in all probability the most favorable for the occurrence of commercial pools of oil and gas. In view of the interest in the geologic structure of the region, the Missouri Geological Survey has recently made a general study of the more prominent anticlines which have a general strike of northwest and southeast.

In the area underlain by the Pennsylvanian, wells have been drilled near Parkville, Platte County; Cainesville and Mount Moriah, Harrison County; Trenton, Grundy County; Chillicothe, Livingston County; Centralia, Boone County; Lamar, Barton County; and La Monte, Pettis County. A majority of these wells penetrated to the Cambrian formations.

In the area underlain by the Mississippian, Devonian, and Ordovician rocks, wells have been drilled near Columbia, Boone County; St. Peters, St. Charles County; Hannibal, Marion County; and St. Louis and Kirkwood, St. Louis County.

In the southern portion of the State, where the Cambrian underlies the entire area, wells have been drilled near Rolla, Phelps County; Cuba, Crawford County; Salem, Dent County; Winona, Shannon County; and Ava, Douglas County.

The wells near Rolla and Lamar were drilled to the underlying granites.

As far as known, no productive horizon has been encountered in these developments.

ALASKA.

During 1910 the Amalgamated Development Co. secured control of the Controller Bay oil wells near Katalla. The five wells previously drilled by the Pacific Mines Co. (Ltd.) were cleaned out and promise to yield a commercial supply of light oil, steel storage being provided for 30,000 barrels of crude oil at tidewater and connected by a 4-inch pipe line to the wells at Katalla, about 9 miles away. Shipments for local consumption as fuel oil will begin in May, 1911.

IMPORTS.

The value of the imports for consumption of petroleum is reported by the Bureau of Statistics as follows for the last four years: 1907, $286,252; 1908, $617,659; 1909, $276,459; 1910, $136,292. The value of the imports for consumption of ozokerite and paraffin for the same period is: 1907, $186,182; 1908, $438,628; 1909, $1,422,126; 1910, $1,025,701.

EXPORTS.

TERRITORIAL SHIPMENTS.

Alaska.—In the following table are given the shipments of petroleum products to Alaska from 1905 to 1910, inclusive:

Shipments of petroleum products to Alaska from other parts of the United States, 1905–1910, 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
1910	18,835,670	477,673	788,154	136,569	626,972	95,483	104,512	38,625

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 1910, inclusive:

Shipments of petroleum products to Hawaii, the Philippines, and Porto Rico, 1905–1910, 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
1910	54,117,100	1,061,060	974,268	160,700	1,359,671	226,481	359,528	133,968
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
1910	13,453	1,098	318,070	42,058	10,643,804	862,496	432,867	95,213
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
1910	8,589	494	874,814	135,290	1,973,369	222,105	283,935	91,356

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, 1909 and 1910.

Exports of mineral oils from the United States in 1909 and 1910, by kind and port, in gallons.

Kind and port.	1909		1910	
	Quantity.	Value.	Quantity.	Value.
CRUDE.				
New York	35,370,334	$2,166,199	36,111,722	$1,887,411
Philadelphia	10,907,686	802,100	4,468,057	345,279
Galveston	156	9	1,910,483	48,051
Other districts	124,059,597	3,059,280	137,620,904	3,123,512
Total	170,337,773	6,027,588	180,111,166	5,404,253
NAPHTHA.				
Baltimore	18,434	2,767	37,500	8,151
Boston and Charlestown	43,005	5,830	39,426	5,430
New York	37,712,825	3,184,669	55,655,027	4,877,905
Philadelphia	15,985,705	1,349,355	20,862,392	1,399,866
Galveston	6,100	1,105	45	9
Other districts	14,992,606	1,256,268	24,100,992	2,115,741
Total	68,758,675	5,799,994	100,695,382	8,407,102
ILLUMINATING.				
Baltimore	10,695,961	642,472	6,943,273	360,707
Boston and Charlestown	175,405	21,267	129,906	13,366
New York	616,183,294	44,288,463	575,978,402	37,530,408
Philadelphia	302,795,972	17,360,414	266,969,325	13,460,502
Galveston	13,510	1,437	352	67
Other districts	116,536,930	5,500,353	90,225,781	4,277,318
Total	1,046,401,072	67,814,406	940,247,039	55,642,368
LUBRICATING AND PARAFFIN.				
Baltimore	5,100,686	746,498	6,037,623	861,290
Boston and Charlestown	217,863	40,788	199,499	37,624
New York	99,517,999	13,261,932	100,415,326	13,937,383
Philadelphia	48,475,280	4,682,042	50,419,517	4,861,179
Galveston	511,450	74,085	943,877	191,275
Other districts	7,816,331	1,210,762	5,816,702	1,032,352
Total	161,639,609	20,016,107	163,832,544	20,921,103
RESIDUUM.				
Boston and Charlestown	424,967	13,997	63,600	2,549
New York	2,965,593	120,510	22,347,546	654,171
Philadelphia	34,512,290	1,166,191	24,257,035	718,568
Other districts	84,063,399	2,879,797	70,937,621	2,356,908
Total	121,966,249	4,180,495	117,605,802	3,732,196
Grand total	1,569,103,378	103,838,590	1,502,491,933	94,107,022

RECAPITULATION BY KINDS, IN GALLONS.

Crude	170,337,773	$6,027,588	180,111,166	$5,404,253
Naphtha	68,758,675	5,799,994	100,695,382	8,407,102
Illuminating	1,046,401,072	67,814,406	940,247,039	55,642,368
Lubricating and paraffin	161,639,609	20,016,107	163,832,544	20,921,103
Residuum	121,966,249	4,180,495	117,605,802	3,732,196
Total	1,569,103,378	103,838,590	1,502,491,933	94,107,022

RECAPITULATION BY PORTS, IN GALLONS.

Baltimore	15,815,081	$1,391,737	13,018,396	$1,230,148
Boston and Charlestown	861,240	81,882	432,431	58,969
New York	791,750,045	63,021,773	790,508,023	58,887,278
Philadelphia	412,676,933	25,360,102	366,976,326	20,785,394
Galveston	531,216	76,636	2,854,757	239,402
Other districts	347,468,863	13,906,460	328,702,000	12,905,831
Grand total	1,569,103,378	103,838,590	1,502,491,933	94,107,022

Exports of mineral oils from the United States in 1909 and 1910, by months, in gallons.

Month.	1909		1910	
	Quantity.	Value.	Quantity.	Value.
January	125,047,993	$8,193,723	100,607,894	$6,692,137
February	91,719,956	6,558,096	103,894,100	6,517,972
March	139,433,675	9,596,123	132,894,466	8,369,396
April	141,999,696	9,444,228	124,145,014	7,764,874
May	117,477,777	8,420,828	139,645,121	8,728,503
June	140,207,288	9,145,656	131,664,396	8,537,394
July	133,750,661	8,793,155	123,078,112	7,894,528
August	127,384,137	8,023,502	142,209,938	9,045,686
September	156,441,521	9,921,758	127,982,115	8,118,525
October	133,499,602	8,669,062	126,611,839	7,763,115
November	139,016,885	8,879,468	128,949,683	7,371,705
December	123,124,187	8,192,991	120,809,255	7,303,187
Total	1,569,103,378	103,838,590	1,502,491,933	94,107,022

The following table exhibits the total production of petroleum from 1901 to 1910, 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 1901 to 1910, inclusive, in gallons.

Year.	Production.		Exports.			
					Mineral, refined or manufactured.	
	Barrels of 42 gallons.	Gallons.	Mineral, crude (including all natural oils, without regard to gravity).		Naphtha, benzine, gasoline, etc.	
			Quantity.	*Value.*	*Quantity.*	*Value.*
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
1910			180,111,166	5,404,253	100,695,382	8,407,102

Year.	Exports.				Exports.			
	Mineral, refined or manufactured.				Residuum (tar, pitch, and all other, from which the light bodies have been distilled).		Total exports.	
	Illuminating.		Lubricating (heavy paraffin, etc.).					
	Quantity.	*Value.*	*Quantity.*	*Value.*	*Quantity.*	*Value.*	*Quantity.*	*Value.*
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
1910	940,247,039	55,642,368	163,832,544	20,921,103	117,605,802	3,732,196	1,502,491,933	94,107,022

Exports of domestic petroleum from Pacific ports during the calendar years 1908, 1909, and 1910 were as follows:

Exports of petroleum from Pacific ports in 1908, 1909, and 1910, in gallons.

Customs district.	1908		1909		1910	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
From—						
Los Angeles	20,720,433	$446,386	18,170,000	$346,300	7,833,000	$141,260
Puget Sound	3,814,301	73,017	3,488,034	72,098	6,113,526	147,652
San Diego			27,580	812	333,609	7,335
San Francisco	64,099,635	1,018,802	83,934,734	1,495,508	127,470,032	2,310,516
Total	88,634,369	1,538,205	105,620,348	1,914,718	141,750,167	2,606,763
To—						
Alaska	11,891,375	176,483	14,034,900	334,258	18,835,670	477,673
Canada	3,492,151	59,765	3,828,934	79,506	5,841,856	140,679
Chile	4,578,000	65,400	17,809,500	268,535	20,630,499	295,072
Guatemala	2,793,000	66,500	1,050,000	15,000	4,872,000	69,600
Hawaii	47,719,900	802,325	43,461,493	845,805	54,117,100	1,061,060
Japan	10,934,433	262,486				
Mexico			27,580	812	333,609	7,335
Panama	7,224,000	105,200	23,882,500	339,150	32,592,000	465,600
Peru	1,100	33	1,516,349	30,690	4,524,133	89,645
Salvador	410	13	1,650	50	1,100	33
Other			7,442	912	2,200	66
Total	88,634,369	1,538,205	105,620,348	1,914,718	141,750,167	2,606,763

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, 1910.

Exports of petroleum in its various forms from the United States for the fiscal years 1907–1910, by countries and kinds, in gallons.

Country and kind.	Year ending June 30—			
	1907	1908	1909	1910
CRUDE.				
Europe:				
Belgium	897,370	52	201,107	104
France	47,777,692	40,555,219	33,168,985	13,087,508
Germany	4,936,082	6,485,413		
Spain	8,603,703	9,526,563	10,038,730	9,691,256
United Kingdom	12,660,797	8,934,223	24,590,204	
Other Europe	150	2,470	511	
	74,875,794	65,503,940	67,999,537	22,778,868
North America:				
Mexico	19,992,434	17,523,440	27,554,581	41,202,786
Cuba	5,385,898	5,040,720	5,493,314	4,713,586
Dominion of Canada	22,571,811	28,577,508	35,366,004	39,222,019
Panama	3,398,100	5,562,745	13,250,620	26,597,900
Other North America	5,305,767	906,405	1,899,204	4,004,453
	53,255,910	57,610,818	83,563,723	115,740,744
South America	23,200	3,365,728	10,182,832	30,353,669
Japan	1,075	8,742,789	8,102,423	
All other countries	20,833	300	6,794	30,704
Total crude	128,175,737	135,223,575	169,855,309	168,903,985
REFINED.				
Naphtha.				
Europe:				
France	5,623,747	10,485,796	23,553,067	6,583,437
Germany	492,865	2,074	750,000	11,394,253
Sweden	336,045	1,267,611	378,558	522,680
United Kingdom	7,222,433	6,843,892	16,148,285	16,924,159
Other Europe	3,016,619	2,701,661	4,623,663	12,419,372
	16,691,709	21,301,034	45,453,573	47,843,901

Exports of petroleum in its various forms from the United States for the fiscal years 1907–1910, by countries and kinds, in gallons—Continued.

Country and kind.	Year ending June 30—			
	1907	1908	1909	1910
REFINED—continued.				
Naphtha—Continued.				
North America	4,770,891	7,994,179	8,704,588	17,320,657
West Indies	131,825	132,171	310,241	320,160
South America	1,934,204	2,499,971	3,690,656	5,785,161
Asia and Oceania	2,214,135	3,588,315	4,602,975	5,210,862
Africa	614,290	726,700	1,069,234	1,170,182
	9,665,345	14,941,336	18,377,694	29,807,022
Total naphtha	26,357,054	36,242,370	63,831,267	77,650,923
Illuminating.				
Europe:				
Belgium	47,942,197	48,597,412	54,429,995	41,287,412
Denmark	16,123,410	17,873,509	20,985,608	20,238,497
France	32,632,548	52,752,810	64,534,115	46,924,343
Germany	120,183,398	151,802,286	131,299,633	151,890,625
Italy	22,627,583	22,926,445	23,355,053	26,057,918
Netherlands	113,779,776	126,335,611	134,656,827	121,808,987
Sweden and Norway	29,799,154	37,738,705	43,186,026	37,187,417
United Kingdom	182,328,955	206,875,262	223,313,293	194,226,610
Portugal	5,265,000	7,759,171	5,999,563	5,751,226
Other Europe	1,395,847	4,002,069	3,182,583	4,191,054
	572,077,868	676,663,280	704,942,696	649,564,089
North America:				
British North America	10,088,253	6,196,631	13,824,783	10,201,902
Central America	2,014,242	2,424,129	2,317,303	2,590,238
Mexico	2,495,070	764,067	511,276	740,615
West Indies—				
British	2,878,322	2,777,266	2,859,903	3,002,377
Other	3,264,340	2,885,350	2,143,867	3,447,741
Other North America	512,331	653,375	683,574	669,073
	21,252,558	15,700,818	22,340,706	20,651,946
South America:				
Argentina	14,900,929	18,532,187	16,384,837	18,490,512
Brazil	24,528,640	24,359,423	27,999,696	29,874,870
Chile	5,842,470	6,250,448	8,264,431	8,059,982
Uruguay	4,875,966	5,158,182	5,154,920	7,009,158
Venezuela	1,422,441	1,207,665	1,372,075	1,444,847
Other South America	3,510,906	3,557,761	3,503,333	3,546,848
	55,081,352	59,065,666	62,679,292	68,426,217
Asia:				
Chinese Empire	77,913,487	103,737,770	87,006,468	65,817,980
Hongkong	12,048,815	11,107,670	10,370,460	12,692,037
East Indies—				
British	37,837,841	39,173,434	42,949,022	37,545,823
Dutch	13,475,350	11,786,410	16,140,190	12,572,121
Other East Indies	2,441,190	5,331,150	8,757,552	4,707,640
Japan	43,810,870	60,540,424	67,707,658	58,067,925
Other Asia	8,775,675	7,973,490	5,610,450	11,596,113
	196,303,228	239,650,348	238,541,800	202,999,639
Oceania:				
British Australasia	21,621,640	22,129,092	26,776,434	26,341,385
Philippine Islands	6,141,490	10,097,393	8,997,610	6,265,167
Other Oceania	4,410	1,285	1,070	121,520
	27,767,540	32,227,770	35,775,114	32,728,072
British Africa	9,976,024	10,966,114	8,484,285	18,135,570
Other Africa	12,070,862	7,451,905	7,778,563	12,522,003
	22,046,886	18,418,019	16,262,848	30,657,573
Total illuminating	894,529,432	1,041,725,901	1,080,542,456	1,005,027,536

Exports of petroleum in its various forms from the United States for the fiscal years 1907-1910, by countries and kinds, in gallons—Continued.

Country and kind.	Year ending June 30—			
	1907	1908	1909	1910
REFINED—continued.				
Lubricating.				
Europe:				
Belgium	10,582,303	9,706,311	9,853,648	10,671,107
France	15,241,696	19,943,853	18,581,934	20,653,620
Germany	19,551,795	22,158,084	19,708,146	20,533,022
Italy	6,179,766	5,845,997	7,656,884	7,606,839
Netherlands	8,808,058	9,650,719	8,372,364	9,571,203
United Kingdom	42,141,248	50,427,085	42,000,598	54,748,608
Other Europe	5,648,556	6,936,297	6,868,299	7,986,759
	108,153,422	124,668,346	113,041,873	131,771,158
North America	4,344,811	4,287,590	4,537,812	6,095,575
West Indies	1,753,262	1,240,239	1,278,500	1,380,979
South America	5,402,478	6,057,608	6,742,209	7,494,903
Asia and Oceania	14,340,665	20,203,987	15,583,310	17,047,643
Africa	2,145,568	3,306,130	3,070,567	6,640,019
	27,986,804	35,095,554	31,212,398	38,659,119
Total lubricating	136,140,226	159,763,900	144,254,271	170,430,277
Residuum (barrels).				
Europe	63,650,768	65,979,758	92,070,389	112,792,362
North America	1,323,710	4,467,937	10,962,529	10,742,492
All other countries	253,531	134,127	155,115	520,409
Total residuum	65,228,009	70,581,822	103,188,033	124,055,263

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 1910, at New York, in cents per gallon.

Week ending—	Refined oil.			Week ending—	Refined oil.		
	New York.				New York.		
	Bulk.	Cases.	Barrels.		Bulk.	Cases.	Barrels.
Jan. 1	4.55	10.45	8.05	July 2	4.15	10.05	7.65
8	4.55	10.45	8.05	9	4.15	10.05	7.65
15	4.40	10.30	7.90	16	4.15	10.05	7.65
22	4.40	10.30	7.90	23	4.15	10.05	7.65
29	4.40	10.30	7.90	30	4.15	10.05	7.65
Feb. 5	4.40	10.30	7.90	Aug. 6	4.15	10.05	7.65
12	4.40	10.30	7.90	13	4.15	10.05	7.65
19	4.40	10.30	7.90	20	4.15	10.05	7.65
26	4.40	10.30	7.90	27	4.15	10.05	7.65
Mar. 5	4.40	10.30	7.90	Sept. 3	4.15	10.05	7.65
12	4.40	10.30	7.90	10	4.00	9.90	7.50
19	4.40	10.30	7.90	17	4.00	9.90	7.50
26	4.40	10.30	7.90	24	4.00	9.90	7.50
Apr. 2	4.40	10.30	7.90	Oct. 1	4.00	9.90	7.50
9	4.25	10.15	7.75	8	3.90	9.40	7.40
16	4.25	10.15	7.75	15	3.90	8.40	7.40
23	4.25	10.15	7.75	22	3.90	8.90	7.40
30	4.25	10.15	7.75	29	3.90	8.90	7.40
May 7	4.25	10.15	7.75	Nov. 5	3.90	8.90	7.40
14	4.25	10.15	7.75	12	3.90	8.90	7.40
21	4.25	10.15	7.75	19	3.90	8.90	7.40
28	4.25	10.15	7.75	26	3.90	8.90	7.40
June 4	4.25	10.15	7.75	Dec. 3	3.90	8.90	7.40
11	4.25	10.15	7.75	10	3.90	8.90	7.40
18	4.15	10.05	7.65	17	3.90	8.90	7.40
25	4.15	10.05	7.65	24	3.90	8.90	7.40

Wholesale prices of refined petroleum at New York at the first of each month, 1906–1910.

Month.	1906			1907			1908			1909			1910		
		Cents per gallon.			Cents per gallon.			Cents per gallon.			Cents per gallon.			Cents per gallon.	
	Date.	In barrels.	In cases.	Date.	In barrels.	In cases.	Date.	In barrels.	In cases.	Date.	In barrels.	In cases.	Date.	In barrels.	In cases.
January	3	7.60	10.30	5	7.50	10.00	4	8.75	10.90	2	8.50	10.90	1	8.05	10.45
February	7	7.60	10.30	2	7.75	10.25	1	8.75	10.90	6	8.50	10.90	5	7.90	10.30
March	7	7.60	10.30	2	7.75	10.25	7	8.75	10.90	6	8.50	10.90	5	7.90	10.30
April	4	7.60	10.30	6	8.20	10.65	4	8.75	10.90	3	8.50	10.90	2	7.90	10.30
May	2	7.60	10.30	4	8.20	10.65	2	8.75	10.90	1	8.50	10.90	7	7.75	10.15
June	6	7.80	10.30	1	8.20	10.65	6	8.75	10.90	5	8.50	10.90	4	7.75	10.15
July	6	7.80	10.30	6	8.45	10.90	4	8.75	10.90	3	8.40	10.80	2	7.65	10.05
August	2	7.80	10.30	3	8.45	10.90	1	8.75	10.90	7	8.25	10.65	6	7.65	10.05
September	7	7.50	10.00	7	8.45	10.90	5	8.75	10.90	4	8.25	10.65	3	7.50	9.90
October	6	7.50	10.00	5	8.45	10.90	3	8.50	10.90	2	8.25	10.65	1	7.50	9.90
November	3	7.50	10.00	2	8.75	10.90	7	8.50	10.90	6	8.15	10.55	5	7.40	8.90
December	1	7.50	10.00	7	8.75	10.90	5	8.50	10.90	4	8.05	10.45	3	7.40	8.90

Monthly average prices, in cents per gallon, of petroleum exported from the United States in bulk, 1907–1910.

Month.	1907		1908		1909		1910	
	Crude.	Refined, illuminating.	Crude.	Refined, illuminating.	Crude.	Refined, illuminating.	Crude.	Refined, illuminating.
January	5.3	6.3	4.9	6.5	3.4	6.5	2.9	6.5
February	4.9	6.1	4.7	6.4	4.6	6.7	2.7	6.0
March	4.8	6.8	5.4	7.1	3.9	6.5	2.7	5.9
April	5.3	6.8	4.5	7.2	3.7	6.8	3.4	6.1
May	4.1	6.1	3.3	7.3	4.9	7.1	3.0	6.1
June	5.8	6.8	5.6	6.8	3.4	6.3	3.6	6.0
July	5.6	6.8	4.6	7.0	2.6	6.5	2.5	6.3
August	5.5	6.8	3.8	6.8	3.9	6.1	2.3	6.1
September	4.8	6.6	4.3	6.7	3.5	6.4	3.4	5.9
October	4.9	6.6	4.9	6.1	2.9	6.2	3.0	5.7
November	4.9	6.6	3.8	6.6	2.9	6.3	3.2	5.0
December	3.7	6.6	3.6	6.4	3.1	6.5	2.9	5.5

FOREIGN OIL FIELDS.

CANADA.

Production.—In the following table is given the total production of petroleum in Canada from 1901 to 1910, inclusive, as reported by the Geological Survey of Canada:

Production of petroleum in Canada, 1901–1910.

Year.	Quantity.	Value.	Average price per barrel.
	Barrels.[a]		
1901	756,679	$1,225,820	$1.62
1902	530,624	951,190	1.79½
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
1910	315,895	388,550	1.23

[a] Barrels of 35 imperial gallons.

In the following table is given the production of crude petroleum in Canada in 1909 and 1910, by districts, as reported by the supervisor of petroleum bounties. These figures represent the quantity of oil on which bounty was paid. The production shows a falling off in 1910, as compared with 1909. The average price per barrel was also less in 1910 than in 1909.

Production of petroleum in Ontario and New Brunswick in 1909 and 1910, by districts, in barrels.

District.	1909	1910
Bothwell	38,092	36,998
Dutton	9,513	7,752
Lambton	243,123	205,456
Leamington	5,929	141
Onondaga (Brant County)	....	1,005
Tilbury and Romney	124,003	63,058
Total Ontario	420,660	314,410
New Brunswick	95	1,485
Total Canada	420,755	315,895

Strenuous efforts have been made to develop the distillation of oil from shales in New Brunswick. Little exploitation has been carried on in the Athabasca oil fields.

In the following table, furnished by the Imperial Oil Co. (Ltd.), is given the production of petroleum in Ontario, Canada, during the years 1901–1910, by districts:

Production of petroleum in Ontaria, Canada, 1901–1910, by districts, in barrels of 35 imperial gallons.

District.	1901	1902	1903	1904	1905	1906	1907	1908	1909	1910
Bothwell	52,873	50,141	48,880	47,654	47,959	43,836	40,556	39,820	38,707	36,615
Coatsworth (Romney)	....	....	....	....	....	....	49,784	11,165	1,082	....
Dutton	10,588	8,867	21,483	14,217	20,976	18,597	14,698	12,268	10,052	7,860
Leamington	....	....	1,190	25,241	113,806	} 35,958	16,210	18,117	9,367	248
Blytheswood	....	....	....	669	....					
Comber	....	....	....	97	....					
Staples	....	....	....	....	....					
East Tilbury	....	....	....	....	....	} 115,400	344,358	170,589	115,862	60,416
Raleigh, including Pardo's Siding and Sandison	....	2,462	1,161	3,274	....					
Moore Township	....	....	....	36,971	93,815	53,030	32,720	25,667	18,033	14,614
Onondaga	....	....	....	....	....	....	....	....	....	1,070
Oil Springs	76,059	60,747	56,405	75,530	78,125	68,100	55,813	61,252	60,868	55,508
Pelee Island	....	....	....	1,023	....	....	....	....	....	....
Richardson Station (Chatham), including Blakely	....	....	....	....	1,249	1,376	940	2,883	2,923	1,689
Thamesville	....	....	....	5,027	2,463	1,585	1,139	853	710	141
Wheatley	....	....	1,995	4,490	1,750	....	....	....	....	....
Petrolia and all other districts	432,906	397,628	350,390	278,299	250,701	247,446	206,285	171,019	156,581	129,372
Total	572,416	519,845	481,504	492,492	610,844	585,328	762,503	513,633	414,185	307,533

Prices.—The average monthly prices per barrel from 1906 to 1910, inclusive, are given in the following table:

Average monthly prices per barrel for crude oil at Petrolia, 1906–1910.

Month.	1906	1907	1908	1909	1910	Month.	1906	1907	1908	1909	1910
January	$1.38	$1.34	$1.34	$1.44	$1.24	August	$1.38	$1.38	$1.44	$1.26	$1.22
February	1.38	1.35	1.34	1.44	1.24	September	1.34	1.38	1.44	1.26	1.22
March	1.38	1.37	1.34	1.44	1.24	October	1.34	1.38	1.44	1.25	1.22
April	1.40	1.38	1.44	1.44	1.24	November	1.34	1.38	1.44	1.24	1.22
May	1.40	1.38	1.44	1.36	1.24	December	1.34	1.38	1.44	1.24	1.22
June	1.40	1.38	1.44	1.33	1.22						
July	1.38	1.37	1.44	1.27	1.22	The year	1.3734	1.37	1.41½	1.33	*a* 1.23

a Price of oil changed June 11 from $1.24 to $1.22.

Imports.—While the production has been decreasing, the imports, as might be expected, have been increasing. The total imports of petroleum oils, crude and refined, in 1910 were 67,949,643 gallons, valued at $3,133,449, in addition to 1,362,235 pounds of wax and candles, valued at $80,106. The oil imports included crude oil, 53,604,053 gallons; refined and illuminating oils, 7,656,727 gallons; lubricating oils, 3,071,257 gallons; other petroleum products, 2,607,606 gallons.

MEXICO.

DEVELOPMENT AND PRODUCTION.

In the report for 1908 it was pointed out that although the production of petroleum in Mexico at that time was not even sufficient for domestic needs, nevertheless the oil fields were potentially of great importance, and that within a few years discoveries were likely to be made which would make Mexico a factor of great significance in the world's petroleum markets. That period has now arrived. Production did not increase very greatly in 1910, but the results of exploration in that year made large supplies certain and gave to Mexico the competitive position toward the oil trade of the United States which has long been imminent.

The proof of a large supply came when the Huasteca Oil Co., controlled by the Doheny interests of California, owners also of the Ebano oil field, drilled in a gusher southwest of the old Dos Bocas well, in the Juan Casiana field. This well is estimated as flowing 25,000 barrels a day. Great enterprise was shown by the Dohenys in building a pipe line from the new gusher to Tampico and in giving orders for the immediate erection of 48 large steel tanks of 55,000 barrels each near Tampico for storing the oil. As stated above, the line was finished too late in the year to admit of great increase in production. But since the close of 1910 the receipts of oil at Tampico have been large, and the prospect is sufficiently good to justify renewed plans for a pipe line to the high plateau for the distribution of oil to Mexico City.

Before the sensation caused by this new development had subsided, it was followed or supplemented by the drilling in of the Potrero del Llano gusher by the Pierson interests. For more than a year the large amount of scattered geologic work of this English firm had been in process of correlation and extension under the supervision of Dr. C. Willard Hayes. The advent of the new gusher was spectacular. When Dr. Hayes left the well on Christmas Day, 1910, he cheered the hopes of the somewhat discouraged driller with the opinion that a good supply of oil would be struck 12 feet deeper. Before he had traveled 50 miles (two days' journey on horseback) the drill had gone 7 feet and oil and gas had thrown the tools out of the well, which began flowing at the rate of 10,000 barrels a day. Within 24 hours the flow increased to 20,000 barrels, the next day to 30,000 barrels, and the gain continued until 160,000 barrels a day was reached—the greatest yield ever recorded in the history of oil production. Fifty-four days after the oil was struck the flow was turned into earthen storage tanks and amounted to 100,000 barrels a day by actual gage. The Lucas gusher at Spindletop, Tex., probably flowed 75,000 barrels a day for a day or two, and the production of some Russian wells is reported at slightly over 100,000 barrels, but none has approached the yield of this "No. 4 Potrero del Llano." This giant well is about 30 miles northwest of Tuxpan and before it could be controlled some of the oil had run into Tuxpan Harbor and threatened the region with fire. A world's record was made in the success achieved in closing in the well, the flow of which was reduced to that from two 8-inch pipes and was limited to about 8,000 barrels a day until storage was provided.

Closing of the Potrero del Llano well.—The device for getting the great well under control was planned by F. Laurie and applied under the supervision of S. Weaver and F. Laurie. In this device a heavy clamp is placed immediately under the collar of the 8-inch casing, of which there are about 1,700 feet in this well. To this clamp, on opposite sides of the casing, are fastened 2-inch rods, hinged near the lower ends. The upper ends of these rods pass through a clamp above an 8-inch T joint having two gate valves. At the lower end of the T joint is a swedge bell nipple, 8-inch to 10-inch. By means of guys the T joint on its hinged supporting rods was swung from a horizontal to a vertical position, bringing the bell nipple directly over the end of the 8-inch casing. The supporting rods are provided with threads and nuts at their upper ends and by means of these nuts the bell nipple was forced down over the end of the casing. An 8-inch pipe was connected to the T and the upper valve was gradually closed, the oil being thus forced through the pipe into the reservoir. The first controlling device had been tested to only 800 pounds, for it was not considered safe to close the well completely. A new T joint, bell nipple, and valves, tested to 2,000 pounds, were later substituted and the well was completely closed. That is its present condition except for a small leakage about the valve gaskets. An earthen reservoir somewhat over 60 acres in extent was quickly and efficiently provided, but in 60 days this was filled with 3,000,000 barrels of oil, although the flow was checked as much as was deemed safe. In the meantime every effort was made to increase the transportation of the oil to Tampico by barges through Lake Tamiahua and the canal. Nevertheless much oil went to waste, and most of this was purposely burned in a safe region before it could reach Tuxpan Harbor in dangerous quantity.

The temperature of the oil as it issues from the well is 147° F. (64° C.). Its gravity is 21° B., or 0.8696 specific gravity at 60° F. It does not show any water. The closed pressure of the well is 825 pounds.

This gusher led to much drilling and to much rivalry in the purchase of oil territory. Over 400 well-drilling outfits were imported into Mexico, chiefly from the United States.

Production.—The best available estimate of the production of petroleum in Mexico from 1907 to 1910 is as follows:

Production of petroleum in Mexico, 1907–1910.

1907	barrels..	1,000,000
1908	do....	3,481,410
1909	do....	2,488,742
1910	do....	3,332,807

The following table shows the quantity of crude petroleum, naphtha, and illuminating oil imported from the United States into Mexico in 1908, 1909, and 1910:

Imports of petroleum and its products from the United States into Mexico, years ending June 30, 1908, 1909, and 1910.

Kind of oil.	1908		1909		1910	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Gallons.		*Gallons.*		*Gallons.*	
Crude	17,523,440	$901,115	27,554,581	$1,184,398	41,202,786	$1,428,632
Naphtha	79,686	17,756	73,819	11,417	61,550	8,246
Illuminating	764,067	114,655	511,276	69,224	740,615	76,952
Lubricating	839,966	178,865	1,165,272	214,457	1,376,321	263,599
Total	19,207,159	1,212,391	29,304,948	1,479,496	43,381,272	1,777,429

Quantity and value of mineral oils imported from the United States into Mexico, 1901–1910.

Year ending June 30—	Mineral.					
	Crude.		Refined, including residuum.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Gallons.		*Gallons.*		*Gallons.*	
1901	8,356,258	$432,022	918,017	$168,773	9,274,275	$600,795
1902	10,844,913	550,694	1,224,589	209,508	12,069,502	760,202
1903	9,859,154	559,332	1,153,015	218,272	11,012,169	777,604
1904	10,938,448	663,575	1,179,894	222,005	12,118,342	885,580
1905	14,036,517	786,613	1,216,421	224,061	15,252,938	1,010,674
1906	14,366,495	766,353	3,295,325	616,479	17,661,820	1,382,832
1907	19,992,434	1,037,226	3,906,472	511,990	23,898,906	1,549,216
1908	17,523,440	901,115	1,839,803	320,235	19,363,243	1,221,350
1909	27,554,581	1,184,398	1,979,093	306,579	29,533,674	1,490,977
1910	41,202,786	1,428,632	2,333,558	357,258	43,536,344	1,785,890

TRINIDAD.

By A. R. Schultz.

During the year 1910 very active prospecting for oil has been carried on in the island of Trinidad. Many new concessions have been obtained from the Government. Many individual prospectors have acquired concessions to carry on development work, but thus far only two companies—one at Brighton and the other at Guapo—have succeeded in doing very much development work. At both places splendid results have been obtained in the way of oil strikes, although at the latter place no oil has been shipped up to the time of writing. Both of the leading companies are reticent about giving out information regarding the production of their wells and very little satisfactory data can be obtained. It is, however, a significant fact that at both places much larger operations are being undertaken, and in the near future large shipments no doubt will be made from both localities. New companies are constantly being organized, and many of the old companies are reorganized or taken in as parts of larger companies. Practically all of the land in the southern half of the island south of an east-west line passing through San Fernando has been taken up and plans have been laid for prospecting in the near future. For the last three or four months [October, 1911] development work in the southeastern part of the island has been continuous. A new company has been organized, which expects to continue the drilling of wells, and is making preparations for the shipment of oil. The new Trinidad Asphalt Co. is daily adding to its storage capacity and increasing the number of wells. It is reported that in the latter part of 1911 oil shipments are being made regularly from Brighton.

BARBADOS.

Development work for oil on Barbados is being continued, and arrangements have been made to have a Government survey made of the entire island. The Government geologist from London expected to begin his surveys early in the month of August, 1911. It is expected that considerable quantities of oil will be developed in parts of the island.

VENEZUELA.

The active oil development carried on in the island of Trinidad has lent stimulus to prospecting for oil all along the north coast of Venezuela. A large English company has concessions to three-fourths of the oil areas in northern Venezuela, and a large part of the remainder is controlled by an American company. Indications of oil are very numerous along the north coast and in the vicinity of the Gulf of Paria. It is very probable that as prospecting continues large pools of oil will be encountered in the region south and west of the Gulf of Paria and along the north coast of Venezuela as far west as the Gulf of Maracaibo. It is not improbable that much the same conditions will be found west of Venezuela all along the gulf coast to the oil fields in Mexico in the vicinity of Tampico. At the present time nearly all the energies are devoted to prospecting, and very little attention has thus far been given to actual development work. It is reported that as soon as the experts now in the field have completed their report on the territory held under Government concessions, active development work will be undertaken.

PERU.

During the year 1910 a new area was developed on the Negritos tract, which yielded exceedingly high-grade oil containing from 30 to 40 per cent of benzine. Of the total production in 1910, amounting to 103,070 metric tons, 102,470 tons were produced from the Negritos field proper, and 600 tons were produced from the Lagunitas tract.

During the year 1910 there was a falling off in the production of the Titicaca field, as some of the wells were shut down a portion of the year, a few of the wells flowing at intervals.

Production.—The production of petroleum in Peru in recent years is shown in the following tables:

Production of petroleum in Peru, 1901–1910, in tons and barrels.

Year.	Production.	
	Metric tons.	Barrels.
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
1910	177,347	1,330,105

[a] Estimated. One metric ton=7.5 barrels.

Production of petroleum in Peru, 1905–1910, 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	543,750	71,429	[a] 76,103	1,011,180
1909	429,195	740,070	70,750	[a] 76,103	1,316,118
1910	400,080	773,025	107,000	[a] 50,000	1,330,105

[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 1910, inclusive:

Production, shipments, and stocks of petroleum, and number of producing wells in Lobitos oil field, 1905–1910.

Year.	Production.		Shipments.	Stocks, Dec. 31.	Producing wells, Jan. 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
1910	53,344	400,080	....	....	....

[a] Estimated.

The following table gives the production of petroleum in the Negritos oil field of Peru from 1904 to 1910, in tons and barrels:

Production of petroleum in Negritos oil field, Peru, 1904–1910.

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
1910	103,070	773,025

Production of petroleum in Zorritos oil field of Peru, 1901–1910, in gallons.

Year.	Crude petroleum.	Refined.[a]	Gasoline.	Benzine.
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	....
1910	[b] 4,494,000	....	....	....

[a] Kerosene. [b] 107,000 barrels.

ARGENTINA.

In a report[1] by Consul General R. M. Bartleman, Buenos Aires, it is stated that the Government commission sent to examine the petroleum wells at Comodoro Rivadavia, Argentina, has made its report, a summary of which, from the Buenos Aires Herald, follows:[2]

It was found that seven wells were in existence, one of which was commenced in 1903. This was put down with the object of boring for water and reached a depth of only 165 meters (meter equals 3.28 feet), its diameter being too small to admit of its being carried farther.

Of the rest, No. 2 (Chubut) was commenced on March 22, 1907, and struck oil on December 13 of the same year at 535 meters, the oil coming to the surface for some time, but eventually requiring a pump to raise it. Up to October, 1909, all the oil used experimentally in Buenos Aires, as well as for local purposes, came from this well. At the time of the commission's visit there were some 2,600 cubic meters (cubic meter equals 35.314 cubic feet) of oil stored there that had been drawn from this well.

Well No. 3 (Sarmiento) was commenced on May 14, 1908, and completed on February 15, 1909. A depth of 545 meters was reached, when a gaseous deposit was entered, whence gas was still issuing with great violence and a roar that was audible at a distance of several hundred meters.

Well No. 4 (Hidrologia) was commenced October 24, 1908, and terminated October 19, 1909. Two veins of petroleum were passed through, one at 535 meters and the other at 567.70. At times the oil rose to the surface spontaneously, at others it required pumping. The oil is contained in an Australian tank of 20 meters diameter and 2 in depth.

Well No. 5 (San Jorge) was put down by contract with a private company. Work was started on September 14, 1909, but, on November 10, the same year, when at a depth of 149 meters, work had to be suspended owing to the gas, which at that depth

[1] Daily Cons. Rept., Aug. 26, 1911.
[2] The 80-page report of the commission, in Spanish, will be loaned to those interested by the Bureau of Manufactures.

rose in enormous quantities, having caught fire. At the time of the commission's visit, in January last, it was still burning, although with somewhat diminished intensity.

Well No. 6 (Division), commenced on January 16, 1910, reached a depth of 530 meters on November 12 of that year, with indications of petroleum, when an accident occurred that rendered the bore useless.

Well No. 7 (Jefe) was commenced on January 1, 1910, and on June 2, five months later, struck oil at 544 meters. When the commission was there the oil was issuing from the well in a thin stream and was being stored in a tank 10 meters above the level of the ground.

As a test of the utility of the oil for fuel, a train weighing 268 tons was sent over a distance of 13½ kilometers (8⅓ miles), performing the journey in 30 minutes, the average upward grade being 1.4 in 100. A pressure of 120 pounds was maintained, and 410 kilos (kilo equals 2.2 pounds) of petroleum were consumed.

Tested with coal under precisely similar conditions, the consumption of fuel was 975 kilograms.

Used for the distiller, it was found that it required 3,300 kilograms of petroleum to obtain 100 cubic meters of water, the consumption being about equivalent to that of coal in this instance. The oil was being used not only on the spot, but also by the Compañia San Jorge, to the entire exclusion of coal; but the largest consumer was the railway.

The price paid by the railway at present for oil is $10 per ton, and until recently an additional $6 per ton for cartage. On the other hand, the price of coal per ton amounted to $40.

The saving effected by using oil for the locomotives under the foregoing conditions was estimated at 83 per cent. Since then, however, the cost of cartage has been saved, the oil now being pumped direct from the wells to the railway reservoirs. Other economies are effected by substituting oil for coal, by the better utilization of heat, the doing away with ashes, facility of transport, cleanness of tubes and ash hole, etc.

The report remarks at the close that if, in countries where coal is produced in great quantities, such as Great Britain, the United States, and Russia, petroleum is held to possess such advantages over coal, in a country like this, destitute of coal and badly off for firewood, these petroleum deposits ought to be regarded as a heaven-sent gift, which should be fully developed without loss of time. It is asked that the sum of $2,000,000 be included in the budget for next year with this object.

RUSSIA.

PRODUCTION.

In spite of continued unfavorable conditions, the production of crude oil increased in Russia from 65,970,350 barrels in 1909 to 70,336,574 barrels in 1910. This was due to the increase in the Grosny field from 6,846,700 barrels to 8,889,359 barrels and in the Surakhany and other new fields to 1,525,604 barrels. The Baku district remained almost stationary, contributing, however, the greater part of the product.

The new district of Maikop became a producer for the first time and yielded 156,640 barrels, delivered through the new pipe line opened during the year.

The greater part of the production is consumed as fuel oil in the form of residuum.

Mr. E. de Hautpick has stated[1] 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 more than 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 burn-

[1] Min. Jour., London, July 9, 1910.

ing which prevail, one ton of oil is claimed to do the work of two tons of coal.

The usual tables of production, refining, and shipment follow:

Production of petroleum in Russia, 1901–1910, by fields.

Year.	Baku.		Grosny.		Maikop.	
	Poods.[a]	Barrels of 42 gallons.	Poods.	Barrels of 42 gallons.	Poods.	Barrels of 42 gallons.
1901	674,543,724	80,977,638	34,910,347	4,190,918		
1902	636,529,000	76,414,045	34,369,572	4,125,999		
1903	596,581,155	71,618,386	33,094,000	3,972,870		
1904	614,115,445	73,723,290	40,095,331	4,813,365		
1905	414,762,000	49,791,356	43,057,052	5,168,914		
1906	447,520,000	53,723,889	38,373,603	4,606,675		
1907	476,002,000	57,143,097	39,214,612	4,707,637		
1908	465,343,000	55,863,504	52,058,895	6,249,567		
1909	492,500,000	59,123,650	57,033,015	6,846,700		
1910	497,842,212	59,764,971	74,048,358	8,889,359	1,304,800	156,640

Year.	Other.		Total.	
	Poods.	Barrels of 42 gallons.	Poods.	Barrels of 42 gallons.
1901			709,454,071	85,168,556
1902			670,898,572	80,540,044
1903			629,675,155	75,591,256
1904			654,210,776	78,536,655
1905			457,819,052	54,960,270
1906	[b] 4,721,000	566,747	490,614,603	58,897,311
1907			515,216,612	61,850,734
1908	[c] 611,221	73,376	518,013,116	62,186,447
1909			549,533,015	65,970,350
1910	[d] 12,708,290	1,525,604	585,903,660	70,336,574

61.05 poods=1 metric ton crude.
[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] Produced in Bereki and Tchimion oil fields.
[c] Produced in Surakhany.
[d] Includes 10,613,909 poods produced in Surakhany, 1,392,306 poods produced in Sviatoi, 610,500 poods produced in Ferghana, and 91,575 poods produced in Taman.

Baku field.—The total production of crude petroleum on the Apsheron Peninsula or Baku field and the shipments of the chief petroleum products from Baku to all points from 1901 to 1910 have been as follows:

Total production of crude petroleum on the Apsheron Peninsula and shipments of petroleum products from Baku, 1901–1910, in barrels.

Year.	Production.	Shipments from Baku.					
		Illuminating.	Lubricating.	Other products.	Residuum.	Crude oil.	Total.
1901	84,216,743	16,072,500	1,615,403	126,410	35,286,778	4,334,574	57,435,665
1902	76,414,045	15,026,000	1,750,367	298,657	38,049,555	4,090,036	59,214,615
1903	71,618,386	18,313,125	2,032,347	117,815	33,763,778	3,172,509	57,399,574
1904	73,723,290	19,205,250	1,896,455	159,355	33,622,111	2,249,340	57,132,511
1905	49,791,356	9,209,125	1,303,912	150,045	29,555,777	2,897,359	43,116,218
1906	53,723,889	8,941,125	1,847,799	179,289	22,697,667	4,001,441	37,667,321
1907	57,143,097	11,450,019	1,724,664	565,689	27,833,892	4,290,500	45,864,764
1908	55,863,504	10,682,750	1,754,034	105,163	23,989,778	5,398,200	41,929,925
1909	59,123,650	8,261,368	1,728,833	1,087,115	23,404,954	6,182,973	40,665,243
1910	59,764,971	9,978,406	1,892,046	1,381,921	24,414,210	6,207,278	43,873,861

The division of the production among the districts of the Apsheron Peninsula or Baku field is as follows:

Production of the several districts of the Apsheron Peninsula, 1901–1910, in barrels.

Year.	Balakhani.	Sabunchi.	Romani.	Bibi-Eibat.	Binagadi.	Total.
1901	14,139,716	35,444,697	15,297,031	16,039,998	56,196	80,977,638
1902	12,185,354	32,071,908	16,800,000	15,298,200	58,583	76,414,045
1903	10,642,274	27,663,859	14,398,951	18,882,294	31,008	71,618,386
1904	9,848,380	26,029,292	16,063,505	21,745,618	36,495	73,723,290
1905	6,866,747	16,494,310	11,230,732	15,175,558	24,009	49,791,356
1906	8,142,017	18,739,015	11,489,796	15,317,647	35,414	53,723,889
1907	8,594,118	22,036,734	10,750,901	15,761,344	....	57,143,097
1908	8,363,860	23,727,367	9,392,557	14,379,720	....	55,863,504
1909	8,763,505	24,873,950	10,492,198	14,753,901	[a] 240,096	59,123,650
1910	8,228,392	23,379,366	11,532,820	14,265,551	[b] 2,358,842	59,764,971

[a] Other. [b] Includes 1,286,599 barrels in other districts.

Production of petroleum from pumping and flowing wells in the Baku field, 1901–1910, by districts, in barrels.

Year.	Balakhani.	Sabunchi.	Romani.	Bibi-Eibat.	Binagadi.	Total.
PUMPING.						
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
1910	8,228,392	23,267,266	10,456,391	13,612,313	[b] 1,323,713	56,888,075
FLOWING.						
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
1910	....	112,100	1,076,429	653,238	[a] 1,035,129	2,876,896

[a] Other. [b] Includes 251,470 barrels in other districts.

In the table following is given a statement of the number and condition of the wells on the Apsheron Peninsula on December 31, 1909 and 1910:

Number and condition of wells in the Baku fields in years ending Dec. 31, 1909 and 1910.

Condition of wells.	Balakhani.		Sabunchi.		Romani.		Bibi-Eibat.		Total.	
	1909	1910	1909	1910	1909	1910	1909	1910	1909	1910
Completed	41	40	102	98	36	43	41	28	220	209
Producing, Dec. 31	761	762	850	915	197	223	273	266	2,081	2,166
Trial pumping, Dec. 31	21	6	26	24	8	5	9	9	44	44
Drilling, Dec. 31	27	22	101	56	33	27	47	40	208	145
Drilling deeper, Dec. 31	51	33	99	95	54	53	58	55	262	236
Cleaning out and repairing	6	4	21	16	15	14	7	5	54	39
Standing idle	435	393	644	629	216	228	121	163	1,416	1,413
Rigs up, ready for drilling	15	16	45	44	10	11	12	13	82	84
New wells sunk	41	40	102	76	36	30	41	23	220	169
Length of wells drilled, in feet	54,943	62,349	171,248	144,053	68,026	65,590	68,257	65,919	362,474	337,911

The stocks of petroleum and petroleum products in the Baku field at the close of 1906 to 1910 were as follows:

Stocks of petroleum in Baku, Dec. 31, 1906–1910, in barrels.

	1906	1907	1908	1909	1910
At oil wells: Crude	930,965	720,288	1,032,413	1,080,432	938,391
At refineries:					
Crude	2,187,339	2,028,812	1,239,736	2,495,087	3,073,853
Illuminating	953,751	1,225,000	675,375	938,971	947,024
Lubricating	387,217	268,949	195,600	247,358	272,017
Residuals	4,669,882	3,822,222	4,804,333	4,703,372	5,647,526
Other products	92,762	179,051	119,370	234,048	224,240
Total	9,221,916	8,244,322	8,066,827	9,699,268	11,103,051

Grosny field.—The following table shows the production in the Grosny field from 1906 to 1910:

Production of petroleum in the Grosny oil field, 1906–1910, 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	4,606,675
1907	33,840,762	4,062,517	5,373,850	645,120	39,214,612	4,707,637
1908	37,741,980	4,530,850	14,316,915	1,718,717	52,058,895	6,249,567
1909	50,997,451	6,122,143	6,035,564	724,557	57,033,015	6,846,700
1910	58,097,733	6,974,518	15,950,625	1,914,841	74,048,358	8,889,359

Well record in the Grosny field in 1907–1910.

Year.	Number of plots.		Total wells.	Producing, Dec. 31.	Boring and deepening, Dec. 31.	Average depth of wells.	Total sum of depth of producing wells.	Total length of wells drilled in the year.
	Producing.	Being exploited.						
						Feet.	*Feet.*	*Feet.*
1907			271	205	45		185,346	
1908			287	172	51	1,348.2	203,574	
1909			320	182	58	1,458.1	250,831	82,537
1910	44	71	343	234	67	1,557		87,836

Crude petroleum on hand in Grosny field Jan. 1, 1910, 285,829 barrels; Dec. 31, 1910, 787,949 barrels.

The following table shows the deliveries of petroleum and petroleum products from the Grosny district from 1906 to 1908:

Deliveries of petroleum and petroleum products from the Grosny district, 1906–1908, in barrels.

Year.	Crude oil.	Kerosene.	Benzine.	Residuals.	Total.
1906	150,825	363,649	178,568	2,462,484	3,155,526
1907	209,584	243,170	342,306	2,199,756	2,994,816
1908	164,294	400,139	288,783	3,061,256	3,914,472

Novorossisk.—The following tables show the shipments of petroleum and its products from Novorossisk from 1906 to 1910, and stocks on December 31, 1910:

Shipments of petroleum from Novorossisk, 1906–1910.

Year.	Crude oil.	Illuminating.[a]	Benzine.	Residuals.	Total.
	Barrels.	*Barrels.*	*Barrels.*	*Barrels.*	*Barrels.*
1906	486	435,670	86,230	347,858	870,244
1907	770	246,246	299,658	209,812	756,486
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*
1907	....	34,414	31,543	24,922	90,879
1908	....	15,824	38,690	18,112	72,626
1909	....	23,248	54,800	49,920	127,968
1910	....	29,216	63,232	66,928	159,376

[a] Refined.

Stocks of petroleum at Novorossisk, Dec. 31, 1910.

	Poods.	Barrels.
Crude	795,400	95,486
Illuminating oils	699,700	87,463
Astatki	565,800	63,000
Other products	889,400	105,900
Total	2,950,300	351,849

Batum.—The following table shows the shipments of petroleum products from Batum from 1908 to 1910:

Shipments of petroleum from Batum, 1908–1910.

Year.	Refined petroleum.	Lubricating.	Residuals.	Total.
	Tons.	*Tons.*	*Tons.*	*Tons.*
1908	460,580	141,986	70,820	673,386
1909	405,857	164,840	78,839	649,536
1910	372,432	183,130	91,411	646,973

The following were the stocks of petroleum products held at Batum at the close of the year from 1907 to 1910, in poods and barrels:

Stocks of petroleum at Batum, Dec. 31, 1907–1910.

	1907		1908		1909		1910	
	Poods.	*Barrels.*	*Poods.*	*Barrels.*	*Poods.*	*Barrels.*	*Poods.*	*Barrels.*
Illuminating	4,232,000	529,000	3,484,000	435,500	2,700,000	350,000	2,590,778	323,847
Lubricating	1,273,000	155,623	1,124,000	137,410	972,000	118,826	1,092,431	133,670
Solar oil	....	....	97,000	11,758	24,000	3,000	} 522,032	60,000
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	4,205,241	517,517

Much attention was given during 1910 to exploring Sakhalin Island for oil. Pitch lakes and other showings of oil are frequent in the Tertiary sandstones all along the Pacific coast of the Russian half of Sakhalin, beginning with Nabil Bay and extending to the northern extremity of the island, a distance of nearly 200 miles. The belt is 6 to 12 miles wide. According to C. W. Purington (Mining Magazine), the most practical point for attacking the oil fields is

Baikal Bay, on the northwest coast. In spite of cold climate and a sparsely populated region, all writers agree that the region would justify development.

AUSTRIA-HUNGARY.

GALICIA.

Production.—Production declined in Galicia for the first time in years. The decline in 1910 amounted to over 15 per cent, whereas in 1909 it had increased 20 per cent. The decline was due to low prices for crude and refined—the result of sharp competition for a market insufficient for the total supply. The low prices of refined oil depressed the operations of the refineries. The exports of crude oil declined because the demand ceased in Roumania, where the domestic production increased and the total supply was adequate.

The most helpful event of the year was the purchase by the Austrian Government of 819,700 metric tons, or nearly half the production. This drew on the stocks of the previous year by 600,000 tons. The Government will extract the naphtha from this crude oil and use the residuum as fuel for railways and in the navy.

In the following table is given a statement of the production of petroleum in Galicia from 1901 to 1910, inclusive:

Production of petroleum in Galicia, 1901–1910.

Year.	Metric centners.[a]	Barrels of 42 gallons.	Year.	Metric centners.[a]	Barrels of 42 gallons.
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
1905	8,017,964	5,765,317	1910	17,625,600	12,673,688

[a] 1 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 1910, inclusive, by fields, in tons:

Production of petroleum in Galicia, 1905–1910, by fields, in metric tons.[a]

Field.	1905	1906	1907	1908	1909	1910
East Galicia:						
Tustanowice	546,556 (with Boryslaw)	562,198	1,011,590 (with Boryslaw)	1,318,710	1,706,435	1,404,320
Boryslaw				266,910	231,195	209,300
Schodnica	60,202	47,151	39,650	36,480	34,860	32,860
Urycz	20,347	17,930	13,510	30,022 (Urycz, Mraznica, and other fields)	28,110	38,170
Mraznica	......	......	1,490			
Other fields	14,246	13,830	12,230			
West Galicia:						
Potok	22,479	16,325	13,850	50,640 (Potok, Rogi, Rowne, and Krosno)	11,370	13,010
Rogi	24,234	11,452	9,033		9,540 (Rogi and Rowne)	8,200
Rowne	1,609	1,536	1,981			
Krosno	43,559	34,268	29,960		20,690	25,200
Tarnawa-Wielopole-Zagorz	[b] 32,956	[c] 24,870	17,390	18,200	6,770	2,700
Kobylanka, Kryg, Zalawie, Lipinki, Libusza, etc	35,608	30,883	25,290	33,060	27,770	28,800
Total	801,796	760,443	1,175,974	1,754,022	2,076,740	1,762,560

[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, 1907–1910, in metric tons.

	1907	1908	1909	1910
Delivered to refineries:				
In Galicia and Bucovina	281,344	457,020	451,290	362,160
In the rest of Austria	422,829	540,820	672,970	547,950
In Hungary	272,995	338,720	384,090	319,380
To the state refinery in Drohobycz	....	....	....	208,760
Total	977,168	1,336,560	1,508,350	1,438,250
Exported	....	....	41,920	3,280
Used as fuel	....	....	120,000	97,430
Left in store	....	....	406,470	....
Delivered to state installation at Kolpen and Modryczu	....	....	....	819,700
Total	....	....	2,076,740	2,358,660

Imports and exports.—In the following table are given the imports and exports of petroleum products into and from Austria-Hungary in 1908, 1909, and 1910:

Imports and exports of petroleum into and from Austria-Hungary in 1908, 1909, and 1910, in metric tons.

Kind.	1908		1909		1910	
	Imports.	Exports.	Imports.	Exports.	Imports.	Exports.
Illuminating oils	1,868	234,160	1,761	290,915	1,460	266,739
Lubricating and other oils	16,268	111,060	19,614	130,862	16,340	138,071
Benzine	8	25,597	10	32,528	40	39,320
Paraffin	357	28,666	507	38,042	455	44,432
Crude petroleum	3,114	6,250	....	51,558	18,967	5,472
Total	21,615	405,733	21,892	543,905	37,262	494,034

ROUMANIA.

PRODUCTION AND DEVELOPMENT.

The production in Roumania showed a gain of 4.3 per cent in 1910 over 1909, or from 9,321,138 barrels to 9,722,957 barrels. This was due to a considerable increase in the production of the Moreni field and a smaller increase in the Campina and the Baicoi fields, which more than offset the decline at Bustenari. In fact, these three principal fields of Roumania changed places in the order of their importance, the Baicoi field, which has had first place for many years, becoming third, the Moreni first, and the Campina second. The production of the recent Tzintea field, which showed a great increase in 1909, remained stationary in 1910.

During the year efforts were made to extend the Bustenari field to the south. This was finally successful. The Anglo-Roumanian Oil Co., the Central Roumanian Co., and the Concordia and the Columbia Cos. secured good wells at somewhat greater depth than has been usual in Bustenari. The statistics of this Bordeni pool are included with Bustenari, and will doubtless do much to offset the decline in Bustenari in 1911.

Oil was obtained at Doicheshti in a small, rather flat anticline about 10 miles west of Moreni, and great hopes were entertained of a new and extensive oil field, but the pool proved rich in gas rather than oil.

The developments at Filipeshti, nearer to Baicoi and Campina, proved more successful, and so considerable a development has been shown as to make it evident that many other pools will probably be developed in Roumania, especially when additional transportation facilities shall be favored by the Government.

The allotment by the Government of the domestic trade among the various refining companies continues, with such changes as have proved valuable to the trade. The export of residuals has increased.

The value of the product showed a very sharp decline for the year, owing to depression in the trade by competition with foreign oils, and in spite of the slightly increased production the total value declined from $11,279,360 in 1909 to $9,034,712 in 1910.

In all probability the production of 1910 would have showed a greater increase but for the decreased price and lack of greater storage facilities. The production in the first months of 1911 has shown an increase, caused by the provision of more storage facilities.

The following table shows the progress made in every branch of the Roumanian petroleum industry during the last six years:

Roumanian petroleum industry, 1905–1910.

[Metric tons.]

	1905	1906	1907	1908	1909	1910
Crude-oil production	614,870	887,091	1,129,097	1,147,727	1,297,257	1,352,289
Crude oil treated at refineries	510,143	748,798	950,614	1,012,616	1,107,825	1,215,299
Output of refineries:						
Benzine	78,182	114,428	146,263	180,190	201,253	230,703
Illuminating oil	153,499	221,683	261,684	248,274	263,998	272,222
Lubricating oil	17,255	53,588	57,337	89,753	43,446	25,064
Residuals	237,677	333,714	452,685	473,770	576,600	667,260
Home consumption:						
Benzine	2,696	4,059	5,689	9,055	14,041	20,314
Illuminating oil	31,558	35,243	38,467	38,422	39,451	41,849
Lubricating oil	6,307	9,848	9,047	11,955	15,698	17,544
Residuals	162,243	237,477	332,999	347,323	366,703	360,351
Fuel at the refineries	....	....	....	113,753	109,077	....
Exports:						
Benzine	46,696	71,114	89,522	122,860	108,218	125,751
Illuminating oil and distillate	118,134	196,631	262,489	263,633	261,637	339,282
Crude, residuals, etc	49,515	53,374	78,423	78,765	49,715	116,223
Paraffin	....	....	151	187	545	285
Stocks on Dec. 31:						
Benzine	20,084	18,275	47,506	44,783	40,071	29,006
Illuminating oil	30,144	48,967	36,128	41,541	79,613	56,557
Lubricating oil and residuals	64,452	67,334	67,816	73,761	157,204	270,493

The statistics given below have been furnished by the Moniteur du Pétrole Roumain.

In the following table is given the production of petroleum in Roumania, by districts and months, during the year 1910, in metric tons:

Production of petroleum in Roumania in 1910, by districts and months, in metric tons.[a]

Month.	District Prahova.					Dambovitza.	Buzeu.	Bacau.	Total.
	Bustenari-Calinet-Bordeni.	Câmpina-Poiana.	Moreni.	Other.	Total.				
January	29,421	26,053	41,182	18,059	114,715	3,168	2,272	1,617	121,772
February	26,207	24,309	37,427	15,089	103,032	2,586	1,741	1,896	109,255
March	28,167	27,168	39,276	10,262	104,873	2,523	2,850	2,177	112,423
April	26,661	23,577	43,326	10,852	104,416	2,828	2,677	2,020	111,941
May	26,508	29,596	46,381	13,019	115,504	2,610	3,334	2,001	123,449
June	25,355	29,623	41,764	15,183	111,925	2,695	3,323	1,917	119,860
July	25,724	31,480	40,591	15,154	112,949	2,852	3,573	2,086	121,460
August	27,015	26,855	38,107	13,025	105,002	4,060	4,160	2,186	115,408
September	28,236	36,595	26,608	12,694	104,133	5,578	4,131	2,011	115,853
October	25,792	26,622	29,973	11,414	93,801	5,489	4,089	1,986	105,365
November	23,817	26,964	30,298	9,639	90,718	4,594	3,721	1,861	100,894
December	25,366	24,540	23,542	10,787	84,235	4,312	3,846	2,216	94,609
Total	318,269	333,382	438,475	155,177	1,245,303	43,295	39,717	23,974	1,352,289

[a] 1 metric ton=7.19 barrels of 42 gallons.

The percentages of the total production furnished by each of the Departments of Roumania is given in the following table:

Percentage of production of petroleum in Roumania, 1906–1910, by Departments.

Department.	1906	1907	1908	1909	1910
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
Prahova	95.39	95.45	95.49	94.23	92.10
Dambovitza	2.28	2.86	2.29	2.33	3.20
Buzeu	1.31	.88	.93	1.96	2.94
Bacau	1.02	.81	1.29	1.48	1.76
Total	100.00	100.00	100.00	100.00	100.00

Percentage of refined products from Roumanian crude petroleum, 1906–1910.

Product.	1906	1907	1908	1909	1910
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Crude benzine	15.3	15.4	17.8	18.1	19.0
Illuminating oil	29.6	27.5	24.7	23.8	22.4
Lubricating oil	7.2	4.4	8.8	3.9	2.0
Residue	44.5	47.3	46.7	52.0	54.9
Loss	3.4	3.4	2.0	2.2	1.7

WELL RECORD.

The well record in Roumania in 1910 is shown in the following table:

Well record in Roumania in 1910, by districts.

District.	Jan. 1, 1910.						Dec. 31, 1910.					
	Bore holes.			Hand wells.			Bore holes.			Hand wells.		
	Producing.	Drilling.	Abandoned.	Producing.	Sinking.	Abandoned.	Producing.	Drilling.	Abandoned.	Producing.	Sinking.	Abandoned.
Prahova	647	237	408	155	39	477	700	203	274	132	67	433
Dambovitza	14	13	12	71	18	77	15	17	22	68	9	118
Buzeu	21	16	15	44	2	63	26	16	10	44	4	63
Bacau	66	24	52	299	30	476	78	8	13	303	25	472
	748	290	487	569	89	1,093	819	244	319	547	105	1,086

The production of petroleum in Roumania in the last 10 years has been as follows:

Production of petroleum in Roumania, 1901–1910, in barrels.

Year.	Quantity.	Year.	Quantity.
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	9,327,278
1905	4,420,987	1910	9,722,958

EXPORTS.

In the following table are given the exports of petroleum products from Roumania in the years 1908, 1909, and 1910, in tons:

Exports of petroleum products from Roumania in 1908, 1909, and 1910, in metric tons.

Kind.	1908	1909	1910
Crude oil, gas oil, lubricating oil, and residuals	76,196	49,715	116,223
Illuminating oil	262,176	261,637	339,282
Benzine	122,332	108,218	125,751
Paraffin scale		545	285
Total	460,704	420,115	581,541

GERMANY.

In the following table are shown the quantity and value of petroleum produced in the German Empire, by States, from 1901 to 1910, inclusive:

Production and value of petroleum in the German Empire, 1901–1910, 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.*
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	5,805,000	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	[a] 29,726	113,518	143,244	1,018,837	10,118,000	2,408,084
1910			145,168	1,032,522	10,146,000	2,414,748

[a] Includes Bavaria.

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 1901 to 1910, taken from the Mineral Statistics of the United Kingdom:

Quantity and value of oil shale produced in Great Britain, 1901–1910, in long tons.

Year.	England.		Scotland.		Wales.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
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	40	34	2,967,017	3,970,723			2,967,057	3,970,757

NEW SOUTH WALES.

The Commonwealth Oil Corporation continued in 1909 and 1910 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, 1901–1910, in long tons.

Year.	Quantity.	Value.
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	48,718	114,932

ITALY.

In the following table will be found the production and value of petroleum in Italy from 1901 to 1910. This table is taken from the volumes of the Rivista del Servizio Minerario:

Production of petroleum in Italy, 1901–1910.

Year.	Number of wells in operation.	Quantity.		Value.	
		Metric tons.	United States barrels.	Lire.[a]	Dollars.
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	12	5,895	42,388	1,178,660	227,481

[a] Lira=$0.193. 1 metric ton, crude=7.1905 barrels.

At the close of 1910 the Italian Government passed a law rescinding the ad valorem duty on all oil produced in the Province of Parma, and also made provision to subsidize companies which drill wells deeper than 1,000 feet in search of oil. There is no doubt as to the occurrence of petroleum in Parma, as peasants have collected it from pools for more than a century for burning in lamps, without refining. The question as to its occurrence in commercial quantity has not been decided. Description of the oil was given in the preceding report.

BRITISH INDIA.

Production.—The following table gives the production of petroleum in India from 1901 to 1910 in imperial gallons reduced to barrels of 42 gallons and in rupees reduced to dollars:

Production and value of petroleum in India, 1901–1910.

Year.	Quantity.		Value.	
	Imperial gallons.	Barrels (42 United States gallons).	Rupees.[a]	Dollars.
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
1910	214,829,647	6,137,990	12,538,905	4,068,039

[a] The value of the rupee is taken as 32.44⅓ cents; 15 rupees=£1.

Production of petroleum in India, 1905–1910, by provinces, in imperial gallons.

Province.	1905	1906	1907	1908	1909	1910
Burma	142,063,846	137,654,261	148,888,002	173,402,790	230,396,617	211,507,903
Eastern Bengal and Assam	2,733,110	2,897,990	3,156,665	3,243,110	3,280,750	3,320,680
Punjab	1,488	871	1,010	420	720	1,064
Total	144,798,444	140,553,122	152,045,677	176,646,320	233,678,087	214,829,647

Imports.—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.

Country.	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

Imports of kerosene into India in 1909–1911, by countries, in imperial gallons.

Country.	1909–10	1910–11
United States	41,259,000	35,292,000
Roumania	1,229,000	....
Straits Settlements	6,577,000	2,090,000
Sumatra	4,692,000	5,882,000
Borneo	6,985,000	7,469,000
Russia	3,304,000	5,842,000
Other foreign countries	4,000	23,000
Total, foreign countries	64,050,000	56,598,000
Coastwise from Burma	81,275,000	91,868,000

JAPAN.

In the following table is given the production of petroleum in Japan from 1901 to 1910, inclusive:

Production of petroleum in Japan, 1901–1910.[a]

[Barrels of 42 gallons.]

Year.	Crude.		Refined.	
	Koku.	*Barrels.*	*Koku.*	*Barrels.*
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	1,657,036	1,882,393	....	....
1910	1,695,950	1,926,599	....	....

[a] Exclusive of 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, 1905–1910, by fields, as reported by the mining bureau of the department of agriculture and commerce, Tokyo:

Production of petroleum in Japan, 1905–1910, 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

Production of petroleuem in Japan, 1905–1910, by fields—Continued.

Field.	1909	1910
	Koku.	*Koku.*
Akita	3,194	12,921
Hokkaido	2,169	1,892
Nagano	64	61
Niigata	1,648,678	1,678,301
Shizuoka	2,931	2,637
Yamagata	....	135
Total	1,657,036	1,695,950
Formosa	5,664	3,208
Total	1,662,700	1,699,158

Production of petroleum in Japan and Formosa in 1906–1910.

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] 6,717	7,631	1,762,181	2,001,838
1908	1,815,001	2,061,841	7,310	8,304	1,822,311	2,070,145
1909	1,657,036	1,882,393	5,664	7,170	1,662,700	1 889,563
1910	1,695,950	1,926,599	3,208	4,062	1,699,158	1,930,661

[a] Estimated.

PRODUCTION OF PETROLEUM IN FORMOSA.[1]

The records of Formosa describe the eruption of mud and the emanation of combustible gas but tell nothing about petroleum. According to the tradition, the Shiukkoko oil field in Shinchikucho was discovered about 60 years ago, and the Chinese Government attempted to work it, but their efforts being without success, the field was entirely abandoned. As soon as Formosa was ceded to Japan, the Japanese Government began to explore for minerals in the islands, but it was only in the 37th year of Meiji (1904) that the special exploration of oil fields was begun by the Government and boring was started by a company.

Within the scope of exploration, indications of petroleum were discovered at nearly 300 localities, which can be grouped into 26 oil belts, extending for not less than 400 miles in total length.

The existence of petroleum is generally indicated either by the crude oil issuing from rock crevices (from the oil-bearing sandstone or shale), by the emanation of combustible gas, by the eruption of mud, or by the flow of saline water accompanied by gas.

In the boring of the Shiukkoko oil field, which commenced in January, 1904 (the 37th year of Meiji), the American system was adopted, and oil was discovered at a depth of 135 feet. Since that time 14 wells have been bored, all of them pumping up the oil from the original oil bed. At present work is going on for the sinking of a well 2,000 feet deep.

[1] From "Geological formations and mineral resources of the islands of Formosa," by K. Fukutome, chief of the mines department, Tokyo, 1910.

From the following analyses the general character of the petroleum gained from the Shiukkoko oil field will be understood:

Analyses of crude petroleum from Shiukkoko, Formosa.

Production.	Percentage.	Specific gravity.	Percentage.	Specific gravity.
Crude oil	....	0.8284	....	....
Volatile oil (under 150°)	10.0	.7880	14.2	0.778
Illuminating oil (between 150° C. and 300° C.)	80.0	.8350	64.4	.830
Heavy oil, paraffin, and residue	10.0	.8760	21.4	.876

The Senshiuryo oil field in Tainancho and the Rokujukei oil field in Kagicho are now being exploited. The American system has been adopted in these places also.

CHINA.

There are two well-recognized oil fields in China, neither of which has yet become of any significance as a producer, but both will be developed with better transportation facilities. The best known field is in the Province of Shensi, reached by way of Yellow River from the seacoast. Here five productive wells were drilled by cooperative work between the national and the provincial governments. The oil is of fairly light gravity and suitable for refining. The other district is in the Province of Szechue. Much less is known of it on account of its inaccessibility.

DUTCH EAST INDIES.

In the following table is given the production of petroleum in the Dutch East Indies during the years 1901 to 1910, inclusive:

Production of petroleum in Dutch East Indies, 1901–1910.

Year.	Borneo.		Java.		Sumatra.		Total.		
	Metric tons.	Liters.	Metric tons.	Liters.	Metric tons.	Liters.	Metric tons.	Liters.	Barrels.
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
1910	633,472	701,853,114	142,503	165,344,877	719,740	886,505,130	1,495,715	1,753,703,121	11,030,620

[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.

WORLD'S PRODUCTION.

World's production of crude petroleum, 1906–1910, by countries.

[Barrels of 42 gallons.]

Country.	1906	1907	1908	1909	1910			
					Rank.	Barrels.	Metric tons.	Per cent of total production.
United States	126,493,936	166,095,335	178,527,355	183,170,874	1	209,556,048	27,940,806	63.99
Russia	58,897,311	61,850,734	62,186,447	65,970,350	2	70,336,574	9,378,210	21.48
Galicia	5,467,967	8,455,841	12,612,295	14,932,799	3	12,673,688	1,762,560	3.87
Dutch East Indies	8,180,657	9,982,597	10,283,357	11,041,852	4	11,030,620	1,495,715	3.37
Roumania	6,378,184	8,118,207	8,252,157	9,327,278	5	9,722,958	1,352,289	2.97
India	4,015,803	4,344,162	5,047,038	6,676,517	6	6,137,990	818,400	1.87
Mexico	....	1,000,000	3,481,410	2,488,742	7	3,332,807	444,374	1.02
Japan	1,710,768	2,010,639	2,070,145	1,889,563	8	1,930,661	257,421	.59
Peru	536,294	756,226	1,011,180	1,316,118	9	1,330,105	177,347	.40
Germany	578,610	756,631	1,009,278	1,018,837	10	1,032,522	145,168	.32
Canada	569,753	788,872	527,987	420,755	11	315,895	42,119	.10
Italy	53,577	59,875	50,966	42,388	12	42,388	5,895	.02 (Italy and Other)
Other	*a* 30,000	*a* 30,000	*a* 30,000	*a* 30,000	13	*a* 30,000	4,000	
Total	212,912,860	264,249,119	285,089,615	298,326,073	....	327,472,256	43,824,304	100.00

a Estimated.

UNITED STATES GEOLOGICAL SURVEY PUBLICATIONS, 1901-1911, ON THE OIL FIELDS OF THE UNITED STATES.

The following publications of the United States Geological Survey refer to the oil fields of the United States; the later papers supplement the general description of the oil and gas fields given in these reports for 1907 and 1908:

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 water resources of the northern portion of the Black Hills and adjoining regions in South Dakota and Wyoming, by N. H. Darton. 1909. 105 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. 50c.

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 Ohio 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.

[a] 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] Geological Survey's stock of the paper is exhausted, but many of the papers marked in this way may 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. Mineral resources 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.

[a] 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.

[a] 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.

[a] 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.

[a] 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.

[a] 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. C. W. Hayes, Waldemar Lindgren, geologists in charge. 1908. 482 pp., 6 pls. 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.

[a] 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.

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[a] Geological Survey's stock of the paper is exhausted, but many of the papers marked in this way may be purchased from the Superintendent of Documents, Washington, D. C., at the prices indicated.

364. Geology and mineral resources of the Laramie basin, Wyoming, by N. H. Darton and C. E. Siebenthal. 1909. 81 pp., 8 pls.
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. 599 pp., 24 pls.

    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.
398. Geology and oil resources of the Coalinga district, California, final report, by Ralph Arnold and Robert Anderson.
401. Relations between local magnetic disturbances and the genesis of petroleum, by George F. Becker. 1909. 24 pp.
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. 1910. 265 pp., 22 pls.
429. Oil and gas in Louisiana, with a brief summary of their occurence in adjacent States, by G. D. Harris. 1910. 192 pp., 22 pls.
431. Contributions to economic geology, 1909, Part II: Mineral fuels. M. R. Campbell, geologist in charge.

    Natural gas in North Dakota, by A. G. Leonard. The San Juan oil field, Utah, by H. E. Gregory. Gas and oil prospects near Vale, Oreg., and Payette, Idaho, by C. W. Washburne. Gas prospects in the Harney Valley, Oregon, by C. W. Washburne. Preliminary report on the geology and oil prospects of the Cantua-Panoche region, California, by Robert Anderson.

450. Mineral resources of the Llano-Burnet region, Texas, with an account of the pre-Cambrian geology, by Sidney Paige. 1911. 103 pp., 5 pls.
452. The Lander and Salt Creek oil fields, Wyoming. The Lander oil field, Fremont County, by E. G. Woodruff; The Salt Creek oil field, Natrona County, by C. H. Wegemann. 1911. 87 pp., 12 pls.
454. Coal, oil, and gas of the Foxburg quadrangle, Pennsylvania, by E. W. Shaw and M. J. Munn. 1911. 85 pp., 10 pls.
456. Geology of the oil and gas fields of the Carnegie quadrangle, Pennsylvania, by M. J. Munn. 1911. 99 pp., 5 pls.
475. Diffusion of petroleum through fuller's earth, by J. Elliott Gilpin and O. E. Bransky.

In preparation.

471. Contributions to economic geology (short papers and preliminary reports), 1910. Part II: Mineral fuels. M. R. Campbell, geologist in charge.

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. Muskogee, Okla., by J. A. Taff. 1906.
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. 1909.
172. Warren, Pa.-N. Y., by C. Butts. 1910.
176. Sewickley, Pa., by M. J. Munn. 1911.
177. Burgettstown-Carnegie, Pa., by E. W. Shaw and M. J. Munn. 1911.
178. Foxburg-Clarion, Pa., by E. W. Shaw, E. F. Lines, and M. J. Munn. 1911.

In preparation.

Claysville, Pa., by M. J. Munn.

[a] The price of folio No. 148 is 50 cents. The other folios named are sold at 25 cents each.

PEAT.

By Charles A. Davis.

NOTES ON PEAT INDUSTRY.

ESSENTIALS OF PRODUCTION OF PEAT FOR FUEL.

Noteworthy progress was made in 1910 in the production of peat fuel in other countries than the United States, not only in the quantity actually marketed but also in methods of production and utilization. In the United States, although it is generally known that there are large quantities of material good for fuel in the peat bogs and swamps of the northern and eastern parts of the country, but little progress has been made in developing this resource on a commercial scale.

Earnest efforts to do this have been made in many places through a long series of years, however, and as failure to get satisfactory returns may be attributed more to ignorance of European progress and methods than to any other one cause, it is thought that a brief summary of the progress already noted may be of value to the owners of peat lands and to others interested in peat utilization in the United States.

Peat must be dried.—Peat must be dried to be successfully used as fuel, because the raw material in undrained deposits has a water content of 85 to 95 per cent or more so closely associated with it that the moisture can only be reduced to a usable degree by evaporation. This large percentage of water must be dug and be manipulated with the peat to separate from it the relatively small quantity of finished product obtainable, for which only a low price can be expected, because coal and other satisfactory fuels already supply the fuel markets.

Peat must be reduced in bulk and increased in density.—If it is to be used as fuel in furnaces of the ordinary patterns, peat must not only be dried, but it must also be reduced in bulk and increased in density. This is most quickly and cheaply done by grinding to a pulp the wet raw material in machines designed for the purpose. This treatment destroys the fibers and other plant remains in the peat, compacts it, hastens drying, and makes it less friable and brittle when dry. Drying is most certainly and cheaply done by exposing the peat pulp in the form of bricks to the air without application of artificial heat.

Storing.—After thorough drying peat fuel that has been treated as described may at moderate cost be transported, stored, and used at places reasonably remote from points of production.

Erroneous methods.—This brief statement serves to epitomize the essentials of the production of peat fuel for domestic use and for the usual forms of power generators. It may be added, however, that millions of dollars in the aggregate have been spent in trying to devise ways to take the wet raw material as it lies in the bog and, by mechanical plants and artificially generated heat, to dry and compact it in a series of operations lasting but a few minutes. These devices have included machinery for dewatering the peat by great direct pressure, by filter presses, by centrifugal machines, by electrical treatment, and by combinations of two or more of these methods. Numerous forms of driers using direct heat or steam heat, either specially generated or derived from the exhaust from machinery used primarily for other purposes, have been built for drying peat. None of these mechanical plants have been successful, and a thorough analysis of the probable cost of operation as compared with a safe estimate of the selling price of the product would have shown at the outset that such complicated plans were likely to prove unsafe investments.

At the time when European engineers were so successful in commercializing the production of fuel briquets from lignites and coal mine refuse, many attempts were made to produce briquets from peat by methods identical with or similar to those in use for briqueting lignite. In general these attempts were unsuccessful, although at least two factories of good capacity were reported to be producing peat briquets commercially in Germany quite recently.

In this brief review it is not possible to summarize all of the plans proposed for making peat into fuel, nor to mention the many complicated and expensive types of machinery that have been designed and constructed for drying and reducing peat to powder in order that equally complex machines might shape it into compact and pleasing forms.

TENDENCY OF EUROPEAN PROGRESS IN PRODUCTION OF PEAT.

The present tendency in the production and use of peat fuel in Europe is toward simplicity. The development and use of elaborate and costly plants is no longer attempted, and the simplest practicable product that can be used efficiently is sought and made. The simplification of processes for making peat fuel has extended to the development of machinery to decrease the employment of hand labor, which, even in regions where laborers are numerous and can be hired at low wages, has hitherto been a source of high cost of production and of restricted output.

The real progress, that which has been demonstrated in plants of commercial size, may therefore be classified under two general heads—methods of increasing production of the fuel itself and methods of deriving more power from the fuel in proportion to the quantity used—that is, of increasing its efficiency. The two lines of progress noted are evidently interdependent, because so long as production is limited, from any cause, use must be limited also. On the other hand, if there is restricted use for any reason, unrestricted production will soon overstock the market and become unprofitable.

Gas producers and gas engines.—For several years past reports of the successful use of peat fuel in gas producers of several types have been published and in this use, apparantly, the greatest progress has been made in utilizing peat fuel as a source of power of great possibilities.

It now seems demonstrated beyond any reasonable doubt that gas engines of the explosive type consuming producer gas may be used with entire success for generating power in any quantity that may be needed. Such engines can be run with high efficiency when supplied with gas of very low heat value, generated from fuels of grades that could not be used as fuel for steam boiler firing, if the gas is furnished to the gas engines in right quantity and is of fairly uniform chemical composition. Moreover, the individual gas engine has been increased in size until it is now comparable in horsepower developed with the largest steam engines.

Gas producer plants of large capacity generating power or fuel gas are much more frequent in European countries than in the United States, although in this country both gas engine and gas producer are replacing the steam engine and boiler to a surprising extent in many types of plants.

The gas producer is essentially a vertical furnace in which a part of the fuel, in a very thick fuel bed, is entirely consumed by combining its combustible elements with the oxygen of a carefully controlled supply of air to develop heat enough to convert the rest of the fuel into free hydrogen and carbon compounds which can be still further made to combine with oxygen with the liberation of heat.

The gas thus developed is called producer gas and is, essentially, a mixture of gases, of which hydrogen and carbon monoxide are the important fuel constituents, and nitrogen from the introduced air and carbon dioxide the diluents.

Sulphate of ammonia.—In addition there are various solid and liquid impurities derived from the fuel during the generating process, which must be removed by washing the gas before it can be used profitably in gas engines; this cleansing is not needed if the gas is used as fuel. Among the substances present in producer gas as it leaves the generator are some which have commercial value. The most readily salable of these is ammonia, which is derived from the combined nitrogen originally contained in the fuel. This may profitably be recovered and fixed as sulphate of ammonia if the quantity of gas generated is large enough to warrant the cost of installing and operating the special form of apparatus needed for the processes involved in combining the ammonia present in the producer gas with sulphuric acid and for the subsequent concentration and purification of the salt on a large scale. The recovery of ammonia as a by-product of gas-producer plant has not generally been found profitable where the capacity was less than 1,000 horsepower, and then only in special forms of gas producers from types of fuel unusually rich in combined nitrogen.

The Mond gas producer.—The principle that ammonia could be profitably recovered during the gasification of low-grade bituminous coals in gas producers was first demonstrated by Dr. Ludwig Mond, who embodied his researches in the special form of gas producer which bears his name. Since this was done nearly a hundred plants in various parts of the world have been equipped with the Mond gas producers, although all are not equipped to recover ammonia. At least one of these plants has a rated capacity of 30,000 horsepower and consumes more than 300 tons of coal daily, and others are of large size. The gas generated in these producer-gas plants is used for almost every purpose for which power and fuel are needed in quantity.

These statements become significant when to them is added a recent announcement by the manufacturers of the Mond gas producers, who have so fully demonstrated the use and value of producer gas for power and fuel. In this announcement they report the facts that they have perfected a type of gas-producer and ammonia-recovery apparatus for gasifying peat and that, after several years of experimentation, they now have in operation three fully equipped commercial plants which successfully use for fuel peat containing as high as 60 to 70 per cent of water. The report further states that from the gas obtained in these plants sulphate of ammonia has been obtained in quantities ranging from 70 pounds per ton of theoretically dried peat gasified, when the peat had 1 per cent of combined nitrogen, to more than 200 pounds per ton when the nitrogen content was 2.3 per cent. The report continues with the statement that, when such plants are carefully managed—

> So great are the profits obtainable that it is often possible, while taking no credit whatever for the value of the power gas, to obtain as much as 100 per cent profit from sulphate of ammonia alone, after making proper allowance for the cost of digging the peat, bringing it to the plant, and for labor, stores, capital, shares, etc. Indeed, with peats comparatively poor in nitrogen, it is possible in many cases to produce the gas for nothing, the cost of power being then merely that of operating the gas engines, together with capital charges on the same.

Although these claims may be somewhat optimistic, it is clear that if each ton of theoretically dry peat gasified yields from 75,000 to 90,000 cubic feet of producer gas, the calorific value of which is from 125 to 135 British thermal units per cubic foot, and also gives 200 pounds of sulphate of ammonia as a by-product, the operation of a plant consuming 10 tons of dry fuel per day would produce a ton of the ammonia salt. The price of sulphate of ammonia has for some years remained very uniform at about $60 per ton in spite of enormously increased production.

That this process is of practical application in the United States and should be investigated carefully by owners of peat lands is further indicated by the composition of some American peats. These often are rich in combined nitrogen, as is shown by the following: In a series of 20 analyses of samples of Ohio peats, made by the Bureau of Mines, the average content of combined nitrogen, on the water-free basis, was 2.79 per cent, the highest of the series having 3.39 per cent and the lowest 2.22 per cent. It must be kept in mind, however, that there are many types of peat in this country and that some of them contain much less nitrogen than the average given for the Ohio peat analyses.

Peat as fuel in large power plants.—The possibility of using peat as fuel in large power plants is much increased by the fact that it can be used with as much as 60 to 70 per cent moisture in the Mond producers, and the assurance that this has been done on a large commercial scale is a very important advance. Hitherto it has been stated that the difficulty of drying peat so that it became efficient fuel made its use in large plants so hazardous that few have been willing to try it. If it can be used in the gas producer when it contains as much as 60 per cent water it will be possible, if necessity should arise, to dig the raw material even during the winter, and by pressure alone to remove nearly enough water to make the material thus obtained serviceable in the gas producer.

The process described is practically very similar to that of the German chemists Frank and Caro, and from these inventors comes also the positive statement of the entire success of their plans, which have been embodied in one or more large commercial electric power stations in Germany, located on peat bogs of large area.

It seems probable, therefore, that within a short time, if these commercial operations are as successful as described, peat will be more widely used as fuel than ever before, and that it may come into use in many parts of the United States where swamps and bogs are common.

Powdered peat at Back, Sweden.—During the year 1910 reports have been published from conservative and reliable sources that at Back, Sweden, the long-continued work of Lieut. H. Ekelund has at last culminated in the successful commercial production of dry powdered peat for fuel, and in a practical method of using the material for generating heat for making steam.

The method used to prepare the raw wet peat is radically different from that used in the United States to produce peat fertilizer filler, a very similar product. At Back the peat is dug by a mechanical excavator, designed especially for digging peat. The peat is macerated and the wet pulp is spread on the bog surface and partly dried. When dry enough to store without deterioration—that is, when it contains less than about 60 per cent of water—the powdered peat is gathered and stored under cover, enough being thus prepared during the short northern summer of Sweden to supply the rest of the plant with raw material for the entire year. This stored peat, as needed, is ground into powder, screened to give uniform size to the dust, and dried by artificial heat in a type of drier invented for the purpose until it contains about 15 per cent of moisture. It is then packed in waterproof bags for storage or shipment.

The statement has been published, as the result of carefully supervised tests, that peat powder made by this method from pure peat, and burned in the way developed by the inventor, is nearly or quite as efficient a fuel as equal weights of good English coal, and that it can be made in the inland districts of Sweden at less than the cost of coal at the same places.

Aside from the value of the type of peat fuel thus produced, the mechanical devices which have been developed at Back for digging, spreading, and handling peat fuel on a large scale, both in the field and in the factory, seem so successful that they may be noted as marking real progress in the difficult matter of insuring large and certain production of peat fuel for any purpose for which it may be required. This peat-powder factory is equipped to produce 10,000 metric tons per year of powdered fuel containing 15 per cent of moisture, and the actual cost of production, ascertained from tests reported to the Swedish Government and including all charges for interest, operation, etc., is said to be about $2.30 per ton as a high estimate.

As powdered coal has been used successfully in a number of important industries for many years and as powdered peat is now being produced in the United States for fertilizer uses, the work of Ekelund is of special interest. If powdered peat can replace powdered coal in the industries in which the latter material is used for fuel, there are, without doubt, many localities in the United States where the industries using powdered fuel could be established, to which coal could not be cheaply transported. This, as well as several uses to which peat powder is put or can be put in this country, make a thorough investigation of Ekelund's method of producing it of special interest and importance.

Cost of labor.—It has been very generally said by those who have studied the methods of making peat fuel in use in Europe that these could not be introduced into the United States because labor is so much more costly here than in the peat-producing countries of Europe. This statement has been so often reiterated that it has almost the standing of an economic law. Its force has been so felt that it may be said that because of it no really well directed efforts have been made in the United States to manufacture machine peat, which is the form of peat fuel successfully made in Europe, by closely following the procedure in vogue and thoroughly proved abroad. Instead of testing these methods, a total of hundreds of thousands of dollars has been spent in trying "new and improved" plans and devices for making peat fuel, with only failure in the end.

It has been the contention of the writer that until the facts were determined by actual tests, under favorable conditions of equipment, location, supervision, and capitalization, the question of successful introduction of the best foreign machinery and methods was, at least, an open one. This position was amply confirmed by the success of the demonstration peat-fuel plant[1] of the Canada department of mines located near Alfred, Ontario, about 45 miles from Ottawa. This was equipped with Swedish machinery of standard make, the reliability of which had been fully proved by commercial use in many parts of Europe.

The operations involved in producing a good quality of air-dried machine peat were carried on exactly as in Europe, including digging the raw peat and turning and gathering the dried product, by hand labor. The other processes were mechanical, the entire plant being driven by a single portable steam engine located at the working opening in the bog and using refuse peat and wood as fuel. The laborers were paid wages equal to those paid in the United States for similar work, and the cost of production per ton of salable material, based on the operation of the plant an entire season of 140 days, at the rate of production attained in 1910, the first year it was operated, was as follows:

Cost of air-dried machine peat at Alfred, Canada.

Cost per ton, on the field	$1.40
Cost per ton, stored in shed	1.65
Cost per ton, loaded on cars	1.65
Cost per ton, in stack	1.70

These cost figures are official; they include interest on capital, amortization, oil, and repair charges, and are derived from the actual production of 1,600 tons of salable material. The actual cost of production for fuel, labor, etc., was about $1 per ton. The output

[1] Bull. Canada Dept. Mines, Mines Branch, No. 4, 2d ed., Ottawa, Canada, 1910.

of the plant could have been doubled by operating night and day and could also have been increased by lengthening the season of operation. On the assumption that 2 tons of this air-dried machine peat are only equal to 1 ton of anthracite—which is a very low valuation, as peat fuel frequently has a fuel value exceeding 9,000 British thermal units per pound and anthracite seldom has more than 13,500 British thermal units per pound—it would still be possible to produce peat fuel and sell it at a profit, while giving full heating value, in those parts of the United States where peat is abundant, if it can be made at the prices reported from this Canadian fuel plant.

Conclusions.—The conclusion to be drawn from this consideration of the facts presented seems plain: It is possible to make a commercial success of the production of machine peat under economic conditions similar to those existing in many parts of the United States by using European machinery and methods. To insure this success, however, the equipment must be carefully selected, sufficient capital fully to equip and support the enterprise must be supplied, and it must be managed by a man thoroughly familiar by training and experience with this work.

If the successful season's work of the Canadian demonstration plant is repeated in following years, its success for 1910 will be considered the most important event in peat-fuel production achieved up to that time in North America. It should be understood, however, that, while the success of this plant seemingly points to success in the adoption of the same methods and similar machinery in the United States, it does not preclude making changes in either machinery or methods which will fit them more exactly to economic conditions existing here after machinery or methods have been given a trial and found insufficient.

The point demonstrated, however, seems clear, that peat fuel of good efficiency can be made at a profit without adopting other methods or machinery. Hand digging, for example, although employed at Alfred, is not essentially a part of the success of the operations there; in fact, one of the changes contemplated for the immediate future in the equipment of the plant is the substitution of a mechanical excavator to dig the raw peat from the bog.

Peat-digging machinery.—In those parts of Europe where peat fuel is made in largest quantities for power production, machinery for digging peat is being developed and tested in commercial plants. During the season of 1910 several patterns of mechanical excavators were given thorough tests at plants working under commercial conditions and were pronounced satisfactory; and these can now be purchased. The essentials of such a mechanical digger are that it shall be of light but very strong build, and that it shall leave the walls of the openings made in the peat with such a slope that breaking down and slumping into the holes is avoided as much as possible, as this makes future work difficult or impossible. It is necessary, also, that the capacity of the digging machinery shall be large and that the cost of operation in power and labor shall be low. One such machine was reported at the end of 1910 to have dug the equivalent of 8 tons of salable peat fuel per hour, requiring but one man more than the number usually needed to operate the engine and machinery used where hand digging is in use; eight or ten men were displaced by this device.

The appearance of such a machine in any country must be considered a distinct advance, and one that may make easier and simpler the development of the peat resources of the United States because it removes the bugbear of "too much hand labor."

For several years past in Oldenburg, Germany, a mechanical peat-fuel plant has been in operation. This consists of simple but effective digging, pulping, and spreading machinery, the engine to run it all being mounted on a platform mounted on trucks which run on rails placed on the surface of the bog. A gasoline engine furnishes the power for all of the machinery and moves the plant forward or backward on the tramway; and but a single man is needed to operate the entire plant. The peat is laid out on the cleared surface of the bog in the form of bricks on the opposite side of the tramway from that on which the digging is done, and is thereafter turned and gathered by hand.

Two types of automatic, self-propelling mechanical plants were developed in North America in 1910, one in the United States and one in Canada. These differed from the German model in many details, but especially in the fact that no rails were needed to support them on the bog surface. Both of the new plants were equipped with a form of movable platform sometimes used on agricultural machinery under the name "caterpillar tracking." These platforms are endless belts of narrow planks linked together by strong chains and passing over the broad supporting wheels, so that they are moved forward with the machine and at the same time give it adequate support on the soft substratum of the peat bog.

In these combined plants the peat is dug, elevated, macerated, spread, and marked automatically, and the amount of manual labor and the number of men employed as compared with older plants is greatly decreased. Either electricity, steam, or gasoline motors may be used in such plants, and but one or two men are needed to operate them, although their output may be very large.

These devices are still in the process of development, but their performance during 1910 was sufficiently good to show that they promise real advancement in the production of peat fuel for all purposes when they are perfected.

The only peat-fuel plant erected in the United States in 1910 was that of the Peat Products Co., at Lakeville, Ind. This plant, however, was not fully equipped until after the end of the year. It is described as a plant in which the peat is dug by the use of a centrifugal pump, pumped to storage bins, and, after some of the water has drained away, dried in a special drier heated by exhaust steam and stack gases. When dry, the peat is reduced to powder, conveyed to a briquetting press, and compressed into compact briquets. The machinery used is all of novel design and is automatic in action.

PRODUCTION.

PEAT FUEL.

The production of peat for fuel in the United States during 1910 was very small. But two or three small experimental plants are known to have been in operation, and these were not run continuously. No figures have been obtainable as to their production, which was insignificant.

PEAT FERTILIZER AND FERTILIZER FILLER.

The production of both furnace or kiln-dried and sun-dried peat powder for fertilizer uses showed a slight increase over that of preceding years. Two new plants were established, one in California and one in Massachusetts, both on an experimental basis and with small production. One plant reported no production in 1910, a net gain of one.

The processes of manufacture at the various plants visited were not modified in any material way during 1910, and generally the artificial drying was done with very considerable waste of heat. The primary cause of this seems to be the small size of the driers used, which necessitates overheating to give required tonnage.

The total production reported was 37,024 short tons, valued at $140,209, an average price per ton of $3.79. The total tonnage exceeded that reported for 1909 by 10,256 tons, but the average price per ton was 65 cents less. As in 1909, however, this lowering of the average price per ton was due partly to the fact that the material was marketed in two forms—"sun dried," that containing a variable percentage of moisture, and "kiln dry" or "bone dry," that which is artificially dried until the water content does not exceed 10 per cent. The average price received for kiln-dry material was $4.60 per ton. The highest price reported was $6 and the lowest was $3.50. The basis of contract prices on this product, as the market now stands, is the percentage of combined nitrogen in the dry product, estimated as ammonia. As this varies, the prices paid vary considerably. The prices received by several of the producers were reported as being unsatisfactory.

PEAT-MOSS STABLE LITTER.

The only firm manufacturing this product, The John E. Baker Moss Co., Garrett, Ind., sold its bog and made no peat litter during 1910.

IMPORTS.

Peat-moss stable litter to the amount of 8,953 short tons, valued at $41,938, was imported into the United States during the year 1910. The quantity varies but slightly from year to year, and the use of the material is confined almost exclusively to the large cities of the coast, except where it has been introduced into the Middle West by a local manufacturer.

The present source of supply is Holland, but the product is extensively manufactured in Sweden, Germany, England, and Ireland for home consumption. The upper layers of poorly decomposed peat found on bogs of northern types constitute the most satisfactory material for this use. Such peat as is found in the sphagnous bogs of the northern United States should be easily worked as a domestic source of supply of this product, and a profitable industry could thus be established.

SUMMARY.

The total production and consumption of peat for all purposes for 1910 is, so far as reported, shown below:

Production and consumption of peat in the United States in 1910, in short tons.

Use.	Production.		Imports.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Fuel						
Fertilizer	37,024	$140,209			37,024	$140,209
Stable litter			8,953	$41,938	8,953	41,938
Total	37,024	140,209	8,953	41,938	45,977	182,147

CEMENT.

By Ernest F. Burchard.

INTRODUCTION.

In presenting herewith the statistics of cement production in 1910 the figures published in the advance chapter from Mineral Resources for 1909, based on nearly complete returns, have been revised to accord with the latest returns collected by the Bureau of the Census, which conducted, in the summer of 1910, a personal canvass of all the manufacturing plants in the United States. The acceptance of the figures obtained by the Bureau of the Census has resulted in increasing slightly the production of both Portland and natural cement in 1909, as reported by the Geological Survey in June, 1910. In the collection of the statistics for 1910 the survey has followed the usual method of correspondence, and the replies have been so prompt that it has been possible to complete, early in the summer of 1911, the figures for the year 1910. On the 1st of January, 1911, according to responses to telegraphic requests sent to the larger cement companies, it was apparent that the Portland cement industry had made a new high record in 1910, and it was then estimated that the production for the year might reach 75,000,000 barrels. That this limit has been exceeded by more than one and one-half million barrels, as is shown by the following statistics, will doubtless prove surprising to nearly everyone closely in touch with the cement industry, since few estimates ventured beyond the limit predicted by the writer.

PRODUCTION.

The total quantity of Portland, natural, and puzzolan cement produced in the United States during 1910 was 77,785,141 barrels, valued at $68,752,092. As compared with 1909, when the production was 66,689,715 barrels, valued at $53,610,563, the year 1910 showed an increase of 11,095,426 barrels, or 16.6 per cent, in quantity, and an increase of $15,141,529, or 28.2 per cent, in value. The increase in quantity is one of the largest ever recorded, and the fact that the increase in value was proportionately higher than the increase in production indicates that trade conditions were slightly more satisfactory than 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 1908 and 1909 are also presented.

Total production of cement in the United States in 1908, 1909, and 1910, by classes.

Class.	1908		1909		1910	
	Quantity (barrels).	Value.	Quantity (barrels.)	Value.	Quantity (barrels).	Value.
Portland	51,072,612	$43,547,679	64,991,431	$52,858,354	76,549,951	$68,205,800
Natural	1,686,682	834,509	1,537,638	652,756	1,139,239	483,006
Puzzolan	151,451	95,468	160,646	99,453	95,951	63,286
Total	52,910,925	44,477,653	66,689,715	53,610,563	77,785,141	68,752,092

PORTLAND CEMENT.

DEFINITION.

Portland cement is produced by burning a finely ground artificial mixture containing essentially lime, silica, alumina, and iron oxide in certain definite proportions. This combination is made by mixing limestone or marl with clay or shale, or by substituting low magnesia blast furnace slag for the clay or shale. The clay, or its equivalent, furnishes silica, alumina, and iron oxide. Impure limestone called "cement rock," in which all the ingredients are present in nearly the proper proportions, is also much used. The mixture should contain about three parts of the lime carbonate to one part of the clayey materials. The burning takes place at a high temperature, approaching 3,000° F., and must therefore be carried on in kilns of special design and lining. During the burning, combination of the lime and silica, alumina, and iron oxide takes place. The product of the burning is a semifused mass called "clinker," which consists of silicates, aluminates, and ferrites of lime in certain fairly definite proportions. This clinker must be finely ground. After such grinding, the powder (Portland cement) will set under water.

PRODUCTION.

The total production of Portland cement in the United States in 1910 as reported to the Geological Survey was 76,549,951 barrels, valued at $68,205,800. It is interesting to note that this quantity reduced to tons is equivalent to 12,986,152 long tons, valued at $5.25 per ton. As compared with the pig-iron output for 1910, which was 27,303,567 long tons, having an estimated value of $425,115,235 or $15.57 per ton, the Portland cement production approximates 47.5 per cent of the quantity of pig iron, and 16 per cent of its value. As compared with the production of Portland cement for 1909, which was 64,991,431 barrels, valued at $52,858,354, the output for 1910 represents an increase in quantity of 11,558,520 barrels, or 17.7 per cent, and an increase in value of $15,347,446, or 29.03 per cent. The average price per barrel in 1910, according to the figures reported to the survey, was a trifle less than 89.1 cents, as compared with 81.3 cents in 1909. 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 per barrel is about 16.4 cents higher than the average price received for cement in the Lehigh district, and 14.1 cents higher than that in the Eastern States; it is 1.9 cents lower than the average price in the Central States, 13.9 cents lower than the price reported from the Western States, 4.9 cents lower than the average price in the South, and 48.9 cents lower than the average price received at the Pacific coast plants. In the average price for the country is included the value of nearly 75,000 barrels of white Portland cement, which sold for an average of $2.86 per barrel.

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 a single State. By the term "producer" is meant a Portland cement manufacturing company, whether the company operates one or more plants. In the table the term "producing plant" is applied to a mill or group of mills located at one place and operated by one company, but each establishment at a different place is counted as a plant. For instance, the plant of the Atlas Portland Cement Co., near Hannibal, Mo., consisting of two mills, is counted as one plant, but the plants of the Lehigh Portland Cement Co., at Ormrod, West Coplay, and Fogelsville, Pa., are counted as three plants, because of their different locations.

Production of Portland cement in the United States in 1909 and 1910, by States.

1909

State.	Producing plants.	Quantity (barrels).	Value.
Pennsylvania	24	22,869,614	$15,969,621
Indiana	6	7,026,081	5,331,468
Kansas	11	5,334,299	3,792,764
Illinois	5	4,241,392	3,388,667
New Jersey	3	4,046,322	2,813,162
Missouri	4	3,445,076	2,808,916
Michigan	12	3,212,751	2,619,259
California	6	4,455,714	6,785,764
Washington	2		
New York	7	2,139,884	1,859,169
Ohio	8	1,813,521	1,359,245
Iowa	1	1,265,944	1,117,338
Kentucky	1		
West Virginia	1		
Texas	3	1,438,021	1,519,267
Oklahoma	2		
South Dakota	1	1,019,328	1,024,317
Colorado	2		
Arizona	1	663,679	923,847
Utah	2		
Maryland	1	949,331	667,163
Virginia	1		
Massachusetts	1		
Alabama	1	1,070,474	878,387
Georgia	1		
Tennessee	1		
Total	108	64,991,431	52,858,354

1910

State.	Producing plants.	Quantity (barrels).	Value.
Pennsylvania	25	26,675,978	$19,551,268
Indiana	5	7,219,199	6,487,508
Kansas	11	5,655,808	5,359,408
California	7	6,385,588	8,843,210
Washington	2		
Illinois	5	4,459,450	4,119,012
Missouri	4	4,455,589	3,858,088
New Jersey	3	4,184,698	3,067,265
Michigan	12	3,687,719	3,378,940
New York	8	3,296,350	2,906,551
Texas	4	2,287,445	2,664,846
Oklahoma	2		
Iowa	2	2,010,379	1,986,694
Kentucky	1		
West Virginia	1		
Ohio	5	1,527,670	1,279,717
Alabama	2	1,481,359	1,323,495
Georgia	1		
Tennessee	1		
Maryland	1	1,206,158	830,218
Virginia	2		
Arizona	1	1,204,761	1,543,620
Colorado	2		
Montana	1		
Utah	3	811,800	1,005,960
Total	111	76,549,951	68,205,800

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 1907, 1908, 1909, and 1910 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, Arizona, and Montana. Under "Pacific coast" are included plants operating in California and Washington. Under "South" are included plants located in Maryland, Virginia, West Virginia, Kentucky, Tennessee, Georgia, Alabama, Oklahoma, and Texas.

Geographic distribution of the Portland-cement industry, 1907–1910.

District.	Output, in barrels.				Average price per barrel.	
	1907	1908	1909	1910	1909	1910
East	27,134,816	23,472,126	29,062,798	34,157,026	$0.71	$0.75
Central	13,479,703	17,744,034	20,669,596	22,617,009	.79	.91
West	4,463,397	5,171,512	7,017,306	7,672,369	.80	1.03
Pacific coast	1,893,004	2,480,100	4,455,714	6,385,588	1.52	1.38
South	1,814,470	2,204,840	3,786,017	5,717,959	.86	.94
Total	48,785,390	51,072,612	64,991,431	76,549,951	....	....

District.	Plants in operation.				Percentage of total output.			
	1907	1908	1909	1910	1907	1908	1909	1910
East	34	28	35	36	55.6	46.0	44.7	44.6
Central	37	40	36	33	27.6	34.7	31.8	29.6
West	10	13	17	18	9.2	10.1	10.8	10.0
Pacific coast	5	6	8	9	3.9	4.9	6.9	8.3
South	8	11	12	15	3.7	4.3	5.8	7.5
Total	94	98	108	111	100.0	100.0	100.0	100.0

PRODUCTION OF THE LEHIGH DISTRICT, 1890–1910.

The Lehigh district of Pennsylvania-New Jersey showed substantial increase in production of Portland cement in both 1909 and 1910, following the first decrease ever recorded, which occurred in 1908. Twenty plants were operated in Pennsylvania and three in New Jersey. The production for 1910 was 26,284,411 barrels, valued at $19,101,675, or 72.7 cents per barrel, which included the value of a small quantity of white Portland cement. This production exceeded the former high level of 1907, and represented an increase in quantity of 2,037,705 barrels and in value of $2,260,295 over the production of 1909. Notwithstanding the actual increase in the production in the Lehigh district in the last two years, the decrease in percentage of cement manufactured in the Lehigh district as compared with the United States at large still continues, as is shown in the table below. In 1909 there were 22 plants producing Portland cement in the

Lehigh district, and the average price per barrel as reported to the survey was nearly 69.5 cents.

The following table shows the annual production in the Lehigh district since 1890, the total production for the country, and the percentage of the Lehigh district output each year to the total production.

Portland-cement production in the Lehigh district and in the United States, 1890–1910, in barrels.

Year.	Lehigh district output.	Total output, United States.	Percentage of total manufactured in Lehigh district.	Year.	Lehigh district output.	Total output, United States.	Percentage of total manufactured in Lehigh district.
1890	201,000	335,500	60.0	1902	10,829,922	17,230,644	62.8
1891	248,500	454,813	54.7	1903	12,324,922	22,342,973	55.2
1892	280,840	547,440	51.3	1904	14,211,039	26,505,881	53.7
1893	265,317	590,652	44.9	1905	17,368,687	35,246,812	49.3
1894	485,329	798,757	60.8	1906	22,784,613	46,463,424	49.0
1895	634,276	990,324	64.0	1907	24,417,686	48,785,390	50.0
1896	1,048,154	1,543,023	68.1	1908	20,200,387	51,072,612	39.6
1897	2,002,059	2,677,775	74.8	1909	24,246,706	64,991,431	37.3
1898	2,674,304	3,692,284	72.4	1910	26,284,411	76,549,951	34.3
1899	4,110,132	5,652,266	72.7				
1900	6,153,629	8,482,020	72.6				
1901	8,595,340	12,711,225	67.7				

GROWTH OF THE PORTLAND CEMENT INDUSTRY, 1890–1910.

The growth of the industry for the years 1890 to 1910, inclusive, is illustrated graphically in figure 1. For comparison the decline in the natural cement industry is plotted on the same diagram.

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, 1870–1910, 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
			1910	76,549,951	68,205,800
			Total	429,224,197	428,977,154

[a] The figures for 1890 and previous 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.

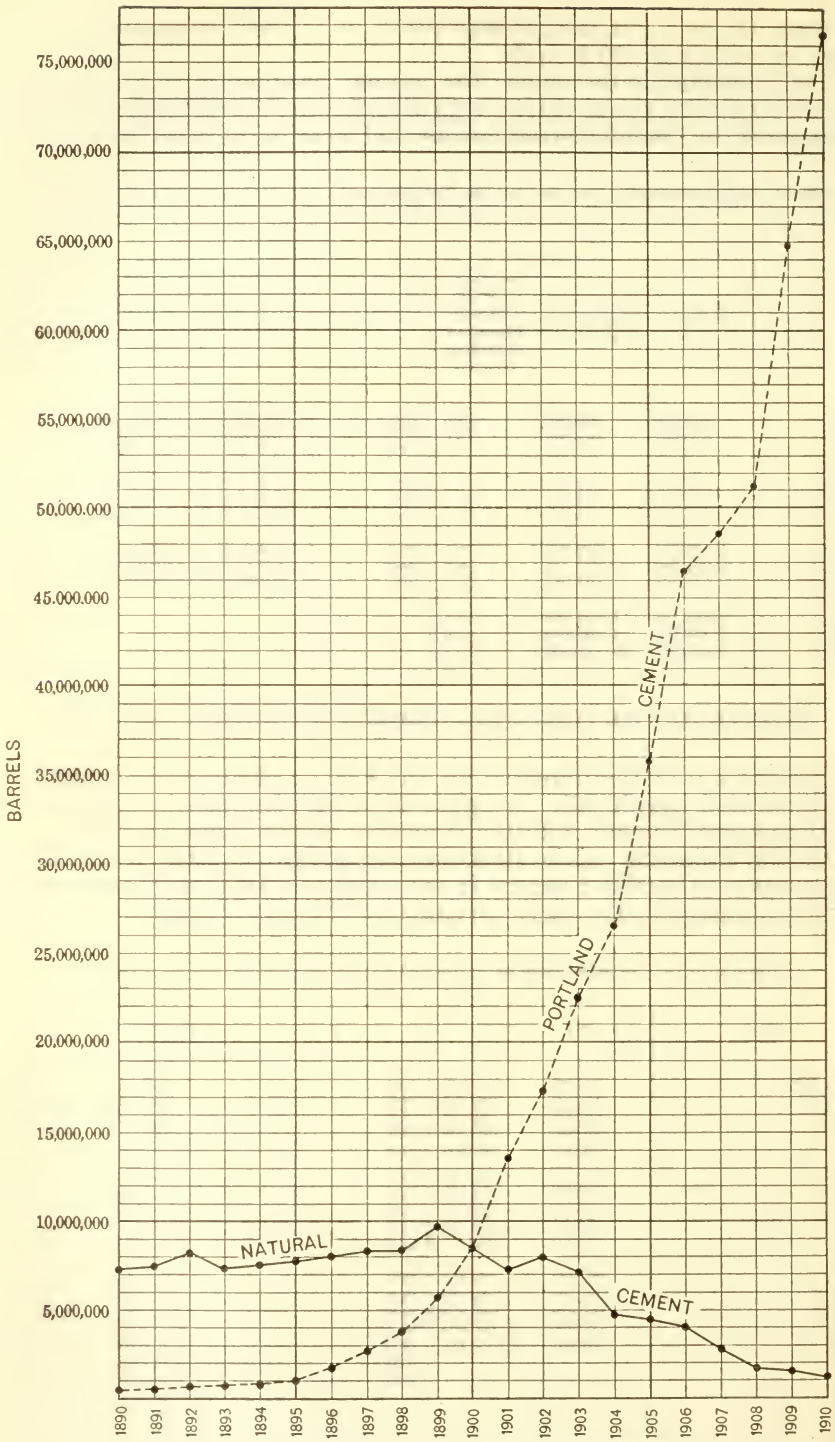

FIGURE 6.—Production of Portland and natural cement, 1890–1910.

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 76,549,951 barrels in 1910. 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 decrease annually, until now it has become a relatively unimportant factor in the cement situation.

CONDITION OF THE PORTLAND-CEMENT INDUSTRY.

In general trade conditions were slightly better in 1910 than in 1909, as is shown both by the higher average price received per barrel and by the increased output, but prices were far from satisfactory, especially in the Lehigh district and in the Eastern States as a whole. Some of the larger plants reported no shutdowns except those caused by accidents or the necessity for repairs, but many others were shut down for intervals ranging from one month to five months on account of full stock houses and little demand for cement at certain seasons. Some plants took advantage of these conditions and made extensive alterations in power plants and grinding machinery during the period of enforced idleness. In Michigan the plants that use marl dredged from lake bottoms are regularly shut down during the winter months, so that the normal manufacturing season is only 9 or 10 months long, but some plants were unable to maintain operations even for this period.

An interesting article has recently been published by E. C. Eckel,[1] after its delivery in the form of an address at the meeting of the Association of Portland Cement Manufacturers in New York City, December 14, 1910. Valuable data showing tonnages, costs, and prices are given, and the significant fact is pointed out that the productive capacity and real capitalization of the cement industry is now about one-half that of the pig-iron industry. In the comparison of the cement and iron industries it is noted that in both cases the capitalization amounts to about $10 per ton of annual product. In the case of the iron industry a ton of the product is worth $15 to $20; in the case of the cement industry it is worth only $4 to $5. The rate of turnover of capital is necessarily much faster in the iron industry than in the cement industry, in which the rate of turnover is practically slower than that of any other industry. In other words, if the profits per ton were 10 per cent of the selling price of both pig iron and cement, the returns to the producer in the case of the iron industry would be 15 to 20 per cent a year profit, while in the cement industry the same capital would produce only 5 per cent profit.

[1] Eckel, E. C., A comparison of the iron and cement industries: Cement Age, Mar., 1911, pp. 139-143; also The cement and iron industries, a comparative study: Eng. Mag., March, 1911, pp. 854-867.

In the comparison of the cement output by districts with the population of the same districts, marked differences in cement production per capita are evidenced. In the Northeastern States (Pennsylvania, New Jersey, and New York) the annual output of cement per capita is in the neighborhood of 435 pounds, which is considerably in excess of that of Germany, and therefore indicates that the industry here has reached the stage at which it may be necessary to build up an export trade in order to maintain good prices and suitable business conditions. In the Southeastern States, on the other hand, the annual production of cement amounts to less than 50 pounds per capita, and indicates that there is a movement of cement from the Northeastern and Central States into the Southeast. Unfortunately, no figures are given with regard to the consumption of cement per capita in any of the sections of the United States, but it is assumed that production and consumption in the States of the Middle West about balance one another. The average production of Portland cement for the whole United States is about 283 pounds per capita, which is reported to be in excess of the German production per capita. In view of the fact that Germany is preeminently a cement-exporting nation, this comparison is in itself of considerable commercial interest.

Eckel further considers that the growth of the Portland-cement industry has not ended, and that its present relative importance is rarely understood. Its increase in size and commercial influence brings certain consequences which might well be borne in mind at present. It can no longer be considered that the cement industry is small and unimportant, and that its condition is purely a matter of private or local interest. On the contrary, it must be realized that the soundness of the cement industry has now become a matter of importance not only to cement manufacturers but to commercial and financial interests generally. In capital employed it probably ranks next to iron and coal among the American industries. It apparently far outranks in this respect the gold-mining industry of the United States, including Alaska. Even the copper industry falls into lower place, for Finlay has recently estimated that the value of all the copper mining and smelting plants of the United States is only $110,000,000. From the banking point of view, therefore, the cement industry is one of the world's three great extractive industries. On the basis of capital actually employed, the pig-iron industry of the United States would represent an actual investment of somewhat over $300,000,000, while the cement industry would represent a little under $150,000,000. The possibility is also pointed out that the cement industry of the future may not be an independent industry, but rather an incidental attachment to the iron and alkali industries. Recent developments have been by some considered as pointing in this direction. The result with regard to costs in at least one of these cases would be little short of revolutionary, but until this tendency is much more clearly defined it can not be taken seriously into account by the cement manufacturer.

With regard to supply and demand the Cement Age says editorially: [1]

Considering the situation throughout the entire country production has not exceeded demand. The one drawback to an otherwise satisfactory condition is that which

[1] Cement Age, December, 1910, pp. 308–311.

attracted attention a year ago, namely, the increasing demand for cement in localities far removed from the large mills. In other words, were it possible to transplant to other localities some of the mills that are now in rather congested districts, making a more even distribution with reference to demand and carrying charges, it is safe to say that the present capacity of the country would soon fail to supply the demand, so rapidly does the consumption of cement increase. The overcrowding problem, therefore, concerns the individual manufacturer, for it can not be said that the industry has declined or is even standing still. On the contrary, the future is most promising. There is abundant reason to believe that the use of cement will show tremendous increase for years to come, and that the consumption five years hence will be astonishingly large compared with the amount used at the present time. The campaign of education inaugurated a few years ago by manufacturers and construction companies directly interested in promoting the use of cement has not only borne fruit, but has been supplemented by the valuable assistance of interests heretofore indifferent in the matter. For example, the great steel interests have realized that increased use of cement means increased demand for their own product. Their engineers and experts are not only giving cement construction technical consideration, growing out of commercial reasons, but are taking an active part in disseminating information as to the utility and economy of concrete. Even some of the clay interests, where represented by far-seeing men, realize the mistake that has been made by seeking to retard the use of concrete. As a specific instance, there may be cited the circular letter sent out to cement manufacturers by the National Paving Brick Manufacturers' Association, in which the first sentence described cement as a most important factor in the construction of vitrified-brick streets, the association even claiming that it has done more than the cement manufacturer to promote the use of cement in this field. While this is a matter of minor importance, it indicates the trend of affairs, just as the use of cement for foundations and drying kilns in brick plants shows how little regard many brick manufacturers have for the statements of agents paid to decry the use of concrete in the interest of brick. Examination of scientific and industrial publications of the past year shows a really remarkable situation so far as it pertains to the use of cement. * * * Engineering societies representing every branch of that profession continue to discuss and publish papers relating to concrete construction. Insurance interests are falling into line, and recent publications of the National Board of Fire Underwriters include recommendations as to the use of concrete.

The impetus given to cement construction by these various influences has been so pronounced that it would be mere conjecture to say when the large percentages of increase in annual output will cease. Most gratifying of all is the fact that back of engineering indorsement and progress is an insistent public demand for cement, a sentiment so pronounced in some localities as to develop antagonism between public officials and the taxpayers where the former have declined to use cement in public improvements. The demand for cement on the farm is growing constantly, and to publish a list of its so-called novel uses would require pages.

Everything considered, the American manufacturer is in better shape than manufacturers abroad. In this connection, however, it may be said that it would profit American manufacturers and engineers to note recent progress abroad. For example we might cite two important and new uses for cement, one the depot for Government archives at Lille, France, and the other the use of cement in mines. The remarkable fireproof properties of concrete led to its adoption in the first instance. The fire-resisting properties of concrete can not be too strongly emphasized, for its virtue in this respect appeals with great force to every man who builds. The use of reenforced concrete in mines illustrates an entirely practical and economical application of cement in a new field. The foreign engineer may have a more restricted field than the American engineer, considering operations from the standpoint of cubic yards, but in progressive ideas and quick perception as to the utility of concrete in untried fields he is more than holding his own.

And, last, but not by any means least, perhaps the most important matter of all has to do with costs. It is a popular fallacy that concrete means excessive cost over other materials. In a majority of cases it probably does exceed the cost of brick and stone, but we are firmly convinced that this is entirely unnecessary. The trouble has been that buildings of concrete have been treated inside and out as though constructed of brick, stone, or timber. We believe this to be nonessential, and that the time is rapidly approaching when concrete will be so acceptable that all exterior and interior plastering and trim will be dispensed with. Then there will be a far different story to tell, and concrete will be known as the cheapest and best of our building materials. This means further education of the public, something that can not be undertaken too soon. A few attractive dwellings in various parts of the country will have an immense influence in promoting this type of construction. Thus the cement manufacturer has it within his power to increase materially the good work he has already accomplished in seeking to promote the use of his product.

In the meantime, American manufacturers have jealously maintained the prestige of the industry so far as the quality of their cement is concerned. There has been no complaint on that score. While there have been no radical changes in manufacturing processes, some improvements have been introduced in the way of mechanical appliances.

PRICES.

The price of Portland cement per barrel in 1910 ranged between 72.7 cents in the Lehigh district and $1.38 on the Pacific coast. There

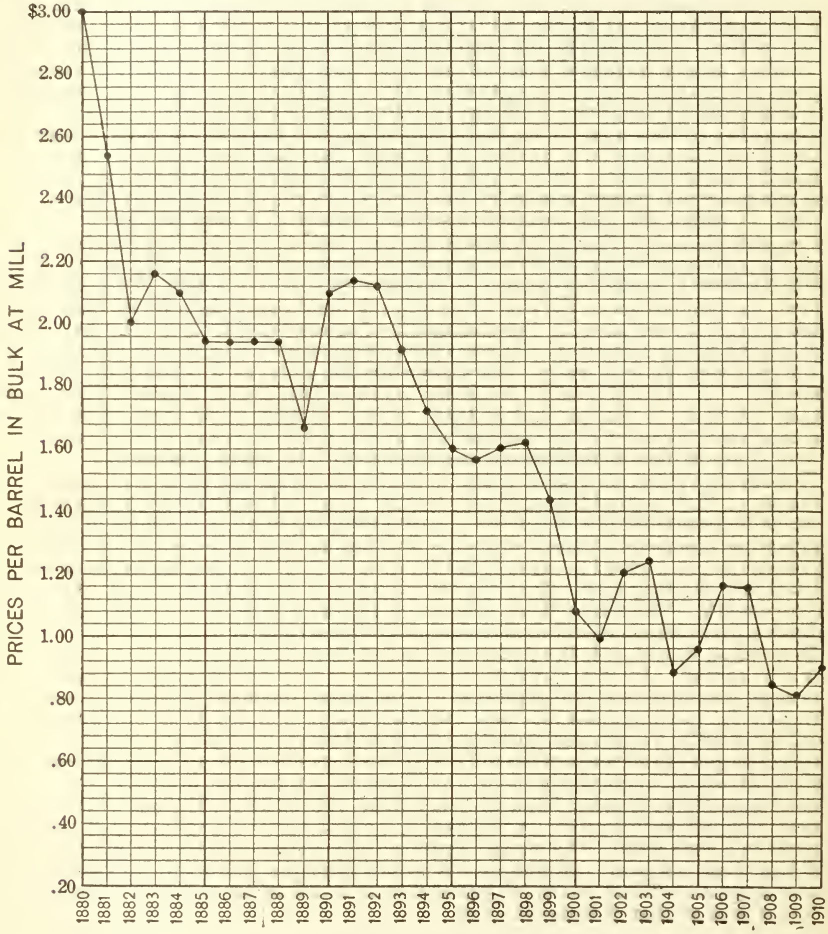

FIGURE 7.—Range in cement prices, 1880–1910.

was more or less fluctuation in price during the year, the highest level being reached during the building season. At the beginning and toward the close of the year when stock houses were full prices went down, and especially at the close of 1910 when a cut of 10 cents per barrel followed the reported dissolution of the Association of Licensed Cement Manufacturers. While the average price for the whole country increased from 81.3 cents in 1909 to nearly 89.1 cents in 1910, with corresponding increases in the east, central, southern, and western districts, the average price in the Pacific coast States dropped from \$1.52 in 1909 to \$1.38 in 1910, a decrease of 14 cents per barrel, due, no doubt, to the advent of a large new mill in California and of new mills in the Rocky Mountain States and western Texas, and to the increased capacity of other plants supplying the coast territory, where attractive prices have hitherto prevailed.

The following table gives the average price per barrel of Portland cement in bulk at the point of manufacture from 1870 to 1910, 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 price per barrel of Portland cement, 1870–1910.

1870–1880	\$3.00	1893	\$1.91	1903	\$1.24
1881	2.50	1894	1.73	1904	.88
1882	2.01	1895	1.60	1905	.94
1883	2.15	1896	1.57	1906	1.13
1884	2.10	1897	1.61	1907	1.11
1885–1888	1.95	1898	1.62	1908	.85
1889	1.67	1899	1.43	1909	.813
1890	2.09	1900	1.09	1910	.891
1891	2.13	1901	.99		
1892	2.11	1902	1.21		

MANUFACTURING CONDITIONS.

In 1910 the plants reported as producing Portland cement numbered 111. The total number of rotary kilns reported as in operation during the year was 902, as compared with 930 in 1909. These kilns ranged in length from 45 to about 240 feet. The distribution of kiln lengths, as reported, was as follows: 264 kilns, 40 to 60 feet; 165 kilns, 70 to 90 feet; 77 kilns, 100 feet; 106 kilns, 110 feet; 71 kilns, 120 feet; 152 kilns, 125 feet; 6 kilns, 135 feet; 40 kilns, 140 feet; and 21 kilns, 150 feet or more. There were thus 473 kilns 100 feet or more in length, as compared with 431 reported in 1909. According to these figures the 125-foot kiln is the most popular size recently constructed. From the reports received it is apparent that the total annual kiln capacity of the country in 1910, allowing for reasonable loss of time for repairs, was about 97,670,000 barrels of Portland cement, and that the total production, 76,549,951 barrels, was about 78 per cent of the total capacity. The apparent average output per kiln in 1910 was about 84,867 barrels, as compared with 69,388 barrels in 1909, the increase due in part to the greater average length of kilns operating in 1910 and in part probably to the fact that the total loss of time due to shutdowns was a little less than in 1909.

According to Frederick A. White,[1] president of the Associated Portland Cement Manufacturers (Ltd.), England, conditions are much similar in the United Kingdom to those in America. He states that it is doubtful whether overproduction ever exists for a long period. When warehouses get full production declines with decreased demand even though the effort to sustain demand depresses prices abnormally. He states that what the cement industry really is suffering from is excess of capacity over current production when that is at low level, because this prevents the natural rebound in price when demand revives, and this appears to be the condition also in the United States.

[1] Cement Age, December, 1910, p. 367.

The table of production by States shows that 111 plants produced Portland cement in 1910, as compared with 108 plants in 1909. Nine new plants began production in 1910, and in addition there were two plants that produced in 1910 but not in 1909. Against this there were idle in 1910 eight plants that produced in 1909, making a net gain of three producing plants. The new plants were the following: Atlantic & Gulf Portland Cement Co., Ragland, Ala.; Riverside Portland Cement Co., Riverside, Cal.; Iowa Portland Cement Co., Des Moines, Iowa; Three Forks Portland Cement Co., Trident, Mont.; New England Lime & Cement Co., Hudson, N.Y.; Allentown Portland Cement Co., Evansville, Pa.; Southwestern Portland Cement Co., El Paso, Tex.; Ogden Portland Cement Co., Bakers Spur, Utah; and Norfolk Portland Cement Corporation, Berkley, near Norfolk, Va. The Quincy plant of the Wolverine Portland Cement Co., Quincy, Mich., produced in 1910 but not in 1909, as did the plant of the American Cement Co., at Egypt, Pa. The plants that were idle in 1910 but not in 1909 were the United States Cement Co., Bedford, Ind.; Berkshire White Portland Cement Co., Clayton, Mass.; Egyptian Portland Cement Co., Fenton, Mich.; Alma Cement Co., Wellston, Ohio; Lehigh Portland Cement Co., Wellston, Ohio; York Portland Cement Co., New Boston, Ohio; Whitehall Portland Cement Co., Cementon, Pa.; and Western Portland Cement Co., Yankton, S. Dak.

NATURAL CEMENT.

DEFINITION.

Natural cements[1] are produced by burning a naturally impure limestone, containing from 15 to 40 per cent of silica, alumina, and iron oxide, at a comparatively low temperature, about that of ordinary lime burning. The operation can therefore be carried on in a kiln closely resembling an ordinary limekiln. During the burning the carbon dioxide of the limestone is almost entirely driven off, and the lime combines with the silica, alumina, and iron oxide, forming a mass containing silicates, aluminates, and ferrites of lime. If the original limestone contained much magnesium carbonate the burned rock will contain a corresponding amount of magnesia.

The burned mass will not slack if water be added. It is necessary, therefore, to grind it rather fine. After grinding, if the resulting powder (natural cement) be mixed with water it will harden rapidly. This hardening or setting will also take place under water. Natural cements differ from ordinary limes in two notable ways:

(1) The burned mass does not slack on the addition of water.

(2) The powder has hydraulic properties; that is, if properly prepared it will set under water.

Natural cements differ from Portland cements in the following important particulars:

(1) Natural cements are not made from carefully prepared and finely ground artificial mixtures, but from natural rock.

(2) Natural cements are burned at a lower temperature than Portland, the mass in the kiln never being heated high enough even to approach the fusing or clinkering point.

[1] Eckel, E. C. Cement materials and industry of the United States: Bull. U. S. Geol. Survey No. 243, 1905, pp. 19-20.

(3) Natural cements, after burning and grinding, are usually yellow to brown in color and light in weight, having a specific gravity of 2.7 to 3.1; Portland cement is commonly blue to gray in color and heavier, its specific gravity ranging from 3 to 3.2.

(4) Natural cements set more rapidly than Portland cement, but do not attain so high tensile strength.

(5) Portland cement is a definite product, its percentages of lime, silica, alumina, and iron oxide varying only between narrow limits, while brands of natural cements vary greatly in composition.

PRODUCTION.

The natural cement produced in the United States during 1910 amounted to 1,139,239 barrels, valued at $483,006, as compared with an output of 1,537,638 barrels, valued at $652,756, in 1909, a decrease in 1910 of 398,399 barrels, or 25.9 per cent, in quantity and of $169,750, or 26 per cent, in value. The average price of natural cement per barrel at the mills was 42.4 cents in 1909 and 43.3 cents in 1910.

PRODUCTION BY STATES.

In the following table the natural cement production of 1910 is classified by States, or groups of States, the figures for 1909 being given for comparison:

Production of natural cement in 1909 and 1910, by States.

State.	1909 Producing plants.	1909 Quantity (barrels).	1909 Value.
New York	7	545,500	$267,188
Pennsylvania	3	295,085	98,673
Indiana ⎫	3		
Illinois ⎬	1	397,574	144,690
Ohio ⎭	1		
Kansas ⎫	1		
Georgia ⎬	1	87,910	45,077
Texas ⎭	1		
Minnesota ⎫	2	211,569	97,128
Wisconsin ⎭	1		
Total	22	1,537,638	652,756

State.	1910 Producing plants.	1910 Quantity (barrels).	1910 Value.
New York	5	304,598	$150,952
Pennsylvania	3	196,331	56,777
Illinois ⎫	1		
Indiana ⎬	2	315,823	115,471
Ohio ⎭	1		
Georgia ⎫	2	37,487	18,931
Kentucky ⎭	1		
Minnesota ⎫	2		
Kansas ⎬	1	285,000	140,875
Texas ⎭	1		
Total	19	1,139,239	483,006

THE NATURAL-CEMENT INDUSTRY, 1818-1910.

The following table contains statistics relative to the natural cement industry since its beginning 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 a continuous decline in production each year, and its production for 1910 is the lowest on record since before 1880.

Production of natural cement in the United States, 1818–1910, in barrels.

1818–1829	300,000	1894	7,563,488
1830–1839	1,000,000	1895	7,741,077
1840–1849	4,250,000	1896	7,970,450
1850–1859	11,000,000	1897	8,311,688
1860–1869	16,420,000	1898	8,418,924
1870–1879	22,000,000	1899	9,868,179
1880	2,030,000	1900	8,383,519
1881	2,440,000	1901	7,084,823
1882	3,165,000	1902	8,044,305
1883	4,190,000	1903	7,030,271
1884	4,000,000	1904	4,866,331
1885	4,100,000	1905	4,473,049
1886	4,186,152	1906	4,055,797
1887	6,692,744	1907	2,887,700
1888	6,253,295	1908	1,686,862
1889	6,531,876	1909	1,537,638
1890	7,082,204	1910	1,139,239
1891	7,451,535		
1892	8,211,181	Total	229,779,142
1893	7,411,815		

The future of the natural-cement industry seems to depend on means of improvement in the manufacture of the cement, chemically or by better mechanical devices, whereby it may be brought nearer to the specifications for high-grade Portland cement. The most recent improvements in the art of manufacturing high-grade natural cements are indicated in various papers recently published with regard to additions of calcium aluminate to lime and to cements.[1] According to the Cement Age [2] the old-established reputation of natural cements in the United States can not be gainsaid, and the total consumption [of nearly 230,000,000 barrels] affords statistical evidence of this reputation. The decline in the use of natural cement has been due principally to the greater tensile strength of Portland cement. At long periods, as shown by many records, the two cements in sand mortars show practically equal results. The curve of the natural cement is a very slow one, but steady, while the curve of Portland cement rises rapidly and keeps on a more level line. The effect of the addition of small percentages of aluminate of lime to natural cements is claimed to give this material in sand mortars almost the strength of Portland cement at all periods, increasing setting time and giving it constancy of volume in the accelerated tests.

PUZZOLAN CEMENT.

DEFINITION.

The cementing materials [3] included under this name are made by mixing powdered slacked lime with either a volcanic ash or a blast-furnace slag. The product is, therefore, simply a mechanical mixture of two ingredients, as the mixture is not burned at any stage of the process. After mixing, the mixture is finely ground. The resulting powder (puzzolan cement) will set under water.

Puzzolan cements are usually light bluish, and of lower specific gravity and less tensile strength than Portland cement.

[1] Spackman, Henry S., Important discoveries in the lime and cement industries: Cement Age, December 1908; see also, by same author, Calcium aluminates; their effect on mortars: Cement and Eng. News, May, 1909; and Aluminates, their properties and possibilities in cement manufacture: Eng. Rec., July 9, 1910. Warner, Charles, Alca-lime plaster: The Mason Builder, October, 1910, pp. 148–149.

[2] Cement Age, December, 1910, p. 368.

[3] Eckel, E. C., Cement materials and industry of the United States: Bull. U. S. Geol. Survey No. 243, 1905, p. 20.

PRODUCTION.

Puzzolan cement was manufactured during 1910 at four plants in the United States. Of the plants that reported production one was located at North Birmingham, Ala.; one at Struthers, Ohio; one at Brier Hill, Ohio; and the fourth at Sharon, Pa. The output reported for 1910 was 95,951 barrels, valued at $63,286. This showed a decrease of 64,695 barrels in quantity and of $36,167 in value, as compared with the production for 1909, which was 160,646 barrels, valued at $99,453. The average price per barrel of puzzolan cement in 1910 was 66 cents; in 1909 it was a trifle less than 62 cents.

The following table contains the leading facts relative to the puzzolan industry for the five years from 1906 to 1910, inclusive:

Statistics of the puzzolan cement industry, 1906–1910, by States.

	1906	1907	1908	1909	1910
Number of plants reporting production:					
Alabama	2	1	1	1	1
Illinois	1	1			
Kentucky	1	1			
Maryland	1				
New Jersey	1				
New York	1	1			
Ohio	2	2	2	2	2
Pennsylvania	1	1	1	1	1
Total	10	7	4	4	4
Production in barrels	481,224	557,252	151,451	160,646	95,951
Value of production	$412,921	$443,998	$95,468	$99,453	$63,286

The following table includes the statistics of 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, 1896–1910, in barrels.

1896	12,265	1905	382,447
1897	48,329	1906	481,224
1898	150,895	1907	557,252
1899	335,000	1908	151,451
1900	446,609	1909	160,646
1901	272,689	1910	95,951
1902	478,555		
1903	525,896	Total	4,402,254
1904	303,045		

PUZZOLAN-PORTLAND CEMENT.

A cement which partakes of the natures of both puzzolan and Portland cements, as described on a subsequent page, is being produced on a large scale in connection with the construction of the Los Angeles aqueduct in California. It is made by regrinding Portland cement with volcanic tuff, and is called locally "tufa cement." About 95,000 barrels of this cement, valued at $1.50 to $1.60 per barrel, were made in 1910, but are not included in the total cement production, since 50,000 barrels of Portland cement were required in the process and the Portland cement so used was included in the total production of Portland cement in the United States.

IMPORTS OF FOREIGN CEMENT.

The following table shows the quantities of foreign cement imported for consumption into the United States during the years 1878 to 1910, 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, 1878–1910, in barrels.[1]

1878	92,000	1889	1,740,356	1900	2,386,683
1879	106,000	1890	1,940,186	1901	939,330
1880	187,000	1891	2,988,313	1902	1,963,023
1881	221,000	1892	2,440,654	1903	2,251,969
1882	370,406	1893	2,674,149	1904	968,409
1883	456,418	1894	2,638,107	1905	896,845
1884	585,768	1895	2,997,395	1906	2,273,493
1885	554,396	1896	2,989,597	1907	2,033,438
1886	915,255	1897	2,090,924	1908	842,121
1887	1,514,095	1898	1,152,861	1909	443,888
1888	1,835,504	1899	2,108,388	1910	306,863

EXPORTS.

The United States possesses a comparatively small export trade in cement, the quantity annually exported ranging usually between 1 per cent and 4 per cent of the domestic production. There seem to be excellent reasons for increasing this export trade as rapidly as possible. The exports in 1910 increased nearly 135 per cent over those of 1909, and if this rate of increase is maintained for a few years, the export trade may soon become an important feature of the industry.

The following table gives the quantity and value of all classes of hydraulic cement exported during the years 1900–1910, inclusive. These totals represent almost entirely exports of Portland cement.

Exports of hydraulic cement, 1900–1910, in barrels.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
1900	100,400	$225,306	1906	583,299	$944,886
1901	373,934	679,296	1907	900,550	1,450,841
1902	340,821	526,471	1908	846,528	1,249,229
1903	285,463	433,984	1909	1,056,922	1,417,534
1904	774,940	1,104,086	1910	2,475,957	3,477,981
1905	897,686	1,387,906			

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

[1] The statistics from 1899 to the present, represent "Imports for consumption." The figures given for all preceding years are for "Total imports."

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, 1902–1910, 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
1910	76,549,951	306,863	76,006,348	2,475,957	74,380,857

PORTLAND 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 1910 was 4,396,282 barrels, as compared with 4,146,708 barrels in 1909, an increase of 249,574 barrels, or 6 per cent. The average price per barrel at the mills in 1910 was $1.34, as compared with $1.31 in 1909. A 350-pound barrel is the standard in Canada. The imports of Portland cement into Canada in 1910 were 349,310 barrels of 350 pounds, at an average price per barrel of $1.34. The imports in 1909 were 142,194 barrels, averaging $1.17 per barrel. The imports into Canada from Great Britain during 1910 were 123,880 barrels, valued at $130,951; from the United States 168,972 barrels, valued at $253,463; from Belgium 19,027 barrels, valued at $20,618; and from other countries 37,431 barrels, valued at $63,014. During the five years preceding 1910 the imports of Portland cement into Canada decreased rapidly, 41 per cent of the whole consumption having been imported in 1905, and only 3 per cent having been imported in 1909, but in 1910 the imports increased to nearly 7 per cent. The duty on cement imported into the Dominion is 12½ cents per hundredweight. The cement exported from Canada in 1910 was valued at only $12,914, so that the consumption in Canada is practically represented by the sales, together with the imports. In 1910 there were reported to be about 18 completed Portland cement plants in Canada.

RECENT DEVELOPMENTS.

CONSTITUTION OF PORTLAND CEMENT.

The most important purely scientific studies of the constitution of Portland cement clinker have been carried on during the last few years by Day, Wright, Shepherd, and Rankin in the Carnegie Geophysical Laboratories, Washington, D. C.[1] The behavior of calcium

[1] Day, A. L., Shepherd, E. S., and Wright, F. E., The lime-silica series of minerals: Am. Jour. Sci., 4th ser., vol. 22, October, 1906, pp. 265–302. Shepherd, E. S., Rankin, G. A., and Wright, F. E., The binary systems of alumina with silica, lime, and magnesia: Am. Jour. Sci., 4th ser., vol. 28, October, 1909, pp. 293–333. Shepherd, E. S., and Rankin, G. A., Preliminary report on the Ternary system $CaOAl_2O_3SiO_2$. A study of the constitution of Portland cement clinker, with optical study by F. E. Wright: Jour. Ind. and Eng. Chem., April, 1911, pp. 211–227.

oxide, silica, and alumina, both in 2-component systems and in 3-component systems, have been observed in detail. In the lime-silica series three stable crystalline forms of the orthosilicate with definite properties were established, and in addition to this, a fourth and apparently unstable crystalline modification, which may be of importance in the constitution of Portland cement, has been discovered. In the early work no trace was found of tricalcic silicate ($3CaOSiO_2$), considered by Le Chatelier, Boudouard, Newberry, Richardson, and others to be present in Portland cement clinker. In the more recent work it has been found that a small addition of alumina brings out the tricalcic silicate, but it appears to have peculiar properties and limitations. For instance, the tricalcic silicate has been found to be unstable at its melting temperature and for some degree below, so that a melt of this compound invariably crystallizes on cooling to orthosilicate and lime. In the presence of alumina, or even alone, if held for a sufficient time at temperatures in the vicinity of 1,800°, the orthosilicate and lime combine to form the new compound with new and independent properties, homogeneous within the limits above noted. As the result of about 800 observations, it has been concluded by these investigators that tricalcic silicate belongs to that class of compounds which form by reaction between the solid components, but which decompose before the melting temperature is reached; that is, they are wholly unstable in contact with the melt. The reaction is, therefore, reversible and would be expressed as follows: $3CaOSiO_2 \rightleftarrows 2CaOSiO_2 + CaO$. The three lines of investigation that are followed in the Carnegie Laboratory are chemical, thermal, and optical. They are not strictly independent, no one in itself being sufficient to solve the problems involved. They overlap to some extent, the data from the one serving to corroborate and to supplement the results obtained by the other method, but the results have demonstrated that too great importance can not be given to the constant use of the microscope in cement study and practice. In fact, microscopic examination may eventually provide much of the desired information about the constitution of samples to be tested, with the advantage over the chemical methods of giving immediate results.

RELATIONS OF CEMENT TO ALKALIES AND SEA WATER.

Progress has been made in investigations of these subjects both at home and abroad. In western United States the alkali and other salts present in the soil in many places are considered by many engineers to have a destructive action upon cement mortars and concrete, although there does not seem to be perfect agreement as to causes or effects. Some tests point to chemical reactions, and others to mechanical action as producing disintegration of the material. Two general remedies have been experimented with, namely, (*a*) waterproofing the cement, and (*b*) adding to the cement some finely ground material such as slag, volcanic ash, tuff, or trass, which shall supply an excess of silica over the quantity required to hold all the lime in combination. Active investigations with regard to the effect of sea water on cement containing puzzolanic materials have been carried on, particularly in France and Germany, during the last year, but the published results are not sufficiently in accord to be reviewed here.

Some interesting municipal work is being carried on by the city of Los Angeles in connection with the construction of the Los Angeles aqueduct.[1] This aqueduct is designed to be 215 miles in length, extending from Owens River, on the eastern face of the Sierra Nevada, to the city of Los Angeles. This aqueduct will include 41 miles of tunnels, 100 miles of covered conduit, 41 miles of open conduit, 12 miles of steel siphon pipe, and 882 feet of concrete flume. The aqueduct is located in a sparsely populated region where transportation charges are unusually heavy. A local railroad has been built from Mohave to the intake, and the freight charges on this line average 4½ cents a ton per mile, or approximately 1 cent a barrel per mile. Southwest from Mohave there is a stretch of 6 miles that diverges from all railroad transportation, at one point the conduit being 35 miles from the nearest railroad. The transportation charges on the cement are a more important factor than its first cost. The city of Los Angeles has constructed a municipal cement mill at Monolith, 15 miles north of Mohave, which is the approximate center of the aqueduct. Although this mill has been successful in producing Portland cement at a reasonable cost near the center of the work, it does not obviate either the high local freight charges north of Mohave, which amount to as much as $1.25 a barrel, or the expensive wagon-haul charge to points southwest of Mohave, which in addition to local railroad freight amounts to as much as $1.50 a barrel. For the purpose of lessening the cost of cement on the work, experiments were conducted on volcanic tuff, which occurs along the line of the Los Angeles aqueduct. Chemical analysis of this material shows it to contain about 69 per cent of silica, 18 per cent of alumina, 0.4 per cent of iron, 2 per cent of lime, 2.7 per cent of magnesia, 0.35 per cent of sulphur, and 7.6 per cent loss on ignition. The material was ground with both lime and Portland cement. The results of grinding the material with Portland cement were so successful that two plants were erected by the aqueduct association, one at Fairmont and the other at Haiwee, and the cement mill at Monolith also has been equipped to grind tuff with Portland cement. The mills consist of rock crushers with elevators, Krupp ball mills, and Allis-Chalmers tube or pebble mills, and are operated by electric motors. The tuff is quarried and run through the rock crusher and the ball mill, passing a 25-mesh screen. At this point the tuff is blended with straight Portland cement, and the blended product is then run through the tube mill, where it is ground so that 90 per cent will pass through a 200-mesh screen. The output of each mill under ordinary working conditions will average about 100 barrels of the blended product per eight-hour shift, although a great deal depends upon the dryness of the tuff when it is fed into the mill. If it is slightly moist, it runs through the fine screen much more slowly than if it is dry. No artificial drying is carried on in the operation, nor is the material heated or burned in any way in the process of manufacture. This mixture, which is practically a puzzolan-Portland cement, consists in the case of the Fairmont mill product of 50 per cent by volume of tuff and 50 per cent of Monolith Portland cement, and at the Haiwee mill of 60 per cent by volume of tuff and 40 per cent of Monolith Portland

[1] Lippincott, J. B., Tufa concrete in the Los Angeles Aqueduct: Cement Age, February, 1911, pp. 86–90; also Tufa concrete: Cement, January, 1911, pp. 359–363. Duryee, Edward, Improved hydraulic cements; Portland cement reground with tufas: Cement and Eng. News, January, 1911, pp. 12–17.

cement. The regrinding results in increasing the fineness of the original Portland cement. The characteristics of this puzzolan-Portland cement, as compared with regular Portland cement, are that the puzzolan-Portland cement requires more water in the mix and hardens more slowly, but continues the hardening process for a greater length of time. It is reported that the puzzolan-Portland cement has proved as strong and as satisfactory generally as straight Portland cement when used in making concrete, but whether the puzzolan-Portland cement possesses marked alkali-resisting qualities has not been definitely ascertained. Its advantage on the Los Angeles Aqueduct is chiefly in the way of economy. The quarry and mill charge for taking one barrel of straight cement and blending it so as to make two barrels of the puzzolan-Portland cement is about 74 cents; the price of straight Portland cement at the points where the tuff plants are located is about $2.50.

Since volcanic tuff deposits occur in many parts of western United States, the use of tuff in the extending of cements may have general commercial importance on account of its economy.

PORTLAND CEMENT MATERIALS AND INDUSTRY OF THE UNITED STATES.

INTRODUCTORY STATEMENT.

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. Many of the Survey publications on this subject are 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.[1]

It is proposed to summarize here the most important limestone formations that have been found to be suitable for the manufacture of Portland cement in the various States. Where possible, notes are given also as to clays or other materials containing silica and alumina that may be combined with the limestones, and in connection with the State descriptions notes are given on the plants at present operating and on the raw materials and fuels which are utilized. The formations mentioned briefly in the following pages are mostly described in

[1] Fall, 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., Jan. 2, 1908.
Hutchison, L. L., Oklahoma Portland cement possibilities: Mfrs. Record, May 20, 1909, p. 45.
Lakes, A., Portland cement material in Colorado: Min. Sci., June 3, 1909, p. 427.
———, Economic resources of the foothills near Denver: Min. Sci., Jan. 12, 1911, p. 31.
Posegate, F. M., Cement and concrete in Oklahoma: Mfrs. Record, Feb. 24, 1910, pp. 55–57.

detail in various reports of State geological surveys listed in the bibliography at the end of this chapter, in geologic folios and bulletins on economic geology issued by the United States Geological Survey, in Bulletin 243 on the cement materials of the United States issued by the survey in 1905, now out of stock, and in a bulletin soon to be issued by the survey on the Portland cement materials of the United States. Some of the data are from notes by the writer not published heretofore. In view of the detailed publication of much of the data elsewhere and on account of space limitations it has been considered inadvisable to give chemical analyses in this report. The distribution of the limestones east of the Rocky Mountains, in California, and in a few other areas, as well as that of the Portland, natural, and puzzolan cement plants in the United States, is shown on the map, Plate XV (in pocket).

ALABAMA.

In Alabama several series of limestones capable of furnishing excellent raw material for the manufacture of Portland cement outcrop extensively, and shale and clay necessary to mix with the limestone are found even more generally distributed. There is marked geologic as well as geographic distinction between the materials that lie in the northern part of Alabama and those that lie in the southern part of the State.

In northern Alabama the raw materials suitable for the manufacture of Portland cement are found in the Paleozoic formations. The limestone belongs mainly to the Mississippian ("Lower Carboniferous") series and to the Chickamauga limestone of the Ordovician system. The clay occurs as residual to rocks of Cambrian and Carboniferous age, and the shale is common to the Pennsylvanian series ("Coal Measures"). The Paleozoic rocks outcrop in broad belts extending northeastward from below Bessemer to beyond the State line into Georgia and Tennessee, and constitute what are popularly known as the "valley rocks." They also form a broad crescentic belt across the northern portion of Alabama, following in general the direction of Tennessee River valley. The purest limestones are those of Chickamauga and Bangor age. The older rocks are often found to contain a considerable proportion of magnesia, which renders them unsuitable for Portland cement manufacture.

In central and southern Alabama the raw materials suitable for the manufacture of Portland cement occur mainly at two horizons, namely, those of the Selma chalk ("Rotten limestone") of the Upper Cretaceous series and the St. Stephens limestone of the Tertiary system. The clays available are residual, having been derived from the decomposition of these two limestone formations. Also, there are stratified clays of the "Grand Gulf" formation, and the alluvial clays that lie in the river and creek bottoms. The limestones just mentioned outcrop in two broad crescentic belts from northwest to southeast across the State. The belt of Cretaceous rocks ranges from 15 to 25 miles in width, and crosses portions of Sumter, Greene, Hale, Dallas, Lowndes, and Montgomery counties. The Tertiary rocks occupy a belt of similar width which crosses portions of Choctaw, Washington, Clarke, Monroe, Conecuh, Covington, Geneva, and Henry counties, and extends southeastward into Florida and eastward into Georgia.

The Paleozoic limestones of northern Alabama furnish a wide range of possibilities for cement manufacture. They are particularly well located with regard to fuel supplies, for they lie within, or on the borders of the Alabama coal field. The Selma chalk is of almost the proper composition, so far as percentage of lime carbonate is concerned, for the manufacture of Portland cement. It requires the addition of little clay, and in consequence the cost of grinding and mixing should be low as compared with a hard limestone-clay mixture. The chalks, however, have a very low silica-aluminum ratio, and are in places difficult to dry properly. The St. Stephens limestone is not so near an ideal composition as the Selma chalk, but may still prove to be a very satisfactory cement material in combination with the overlying "Grand Gulf clay." So far as transportation facilities are concerned, cement plants located where the Cretaceous and Tertiary rocks cross the navigable rivers of Alabama should be able to place their product at points on the Gulf or the southern Atlantic seaboard at low prices, owing to the cheapness of water transportation.

At present three plants are in existence in Alabama. The plant of the Alabama Portland Cement Co. is located at Spocari, near Demopolis, and uses soft chalky limestone of the Cretaceous system, and a residual clay, both of which occur near the plant. The plant of the Standard Portland Cement Co. is located at Leeds. The raw materials used at this plant are hard limestone of Chickamauga age and shale of the Clinton ("Rockwood") formation. The plant of the Atlantic & Gulf Portland Cement Co. has recently been built near Ragland. Hard Chickamauga limestone and Carboniferous shale are used at this plant. Coal is used as fuel in both plants. Several other prospective plants are reported to be in various stages of promotion or construction: A plant at St. Stephens, near Mobile, to use St. Stephens limestone and overlying clay; a plant near Blount Springs, to use Bangor limestone and probably shale of the Clinton formation; and a plant near Ensley, to use blast furnace slag and probably either limestone of Chickamauga or of Bangor age.

ARIZONA.

Owing to the comparatively little developed character of Arizona not much detailed information is available concerning either the area, the distribution, or the chemical composition of the Arizona limestones. Reports on mining districts contain scattered notes on the distribution of various limestone formations, but rarely contain analyses. Limestone formations are known to outcrop in the northern part of the Territory near Colorado River, and in the south-central part of the Territory near Salt River, as well as at other scattered points. Owing to the necessity for securing large quantities of cement at a reasonable price for one of the largest of the irrigation dams, the Roosevelt Dam, a small Portland cement plant was built and operated from 1905 until 1910 by the United States Reclamation Service. The raw materials, limestone and clay, were found to be of satisfactory quality, and a considerable saving was made after deducting the cost of the plant. Oil was used as kiln fuel. Recently this plant has been sold to the Arizona Cement Co. and moved to a point near Phoenix, where it is purposed to continue the manufacture of Portland cement.

ARKANSAS.

The limestones that may be available for Portland-cement manufacture in Arkansas lie principally in the northwestern part of the State, in what is known as the Ozark Plateau region, and in the southwestern part of the State between Texarkana and Hot Springs. Southeast of a line drawn diagonally from Paragould to Texarkana there are no limestones suitable for use in cement manufacture. The limestones in the Ozark region are as follows: The Izard and the Polk Bayou, of Ordovician age; the St. Clair, of Silurian age; and the Boone and the Pitkin, of Mississippian ("Lower Carboniferous") age. In southwest Arkansas the Annona ("White Cliffs") chalk and the "Saratoga" chalk, member of the Marlbrook marl, occur, both being members of the Upper Cretaceous series. The clays principally available for use with the limestones of the Ozark region are residual in nature, but there are also certain shale formations, such as the Chattanooga shale, of Devonian age, and certain shale formations in the Pennsylvanian series, which may be of suitable composition.

The only plant that has been erected in Arkansas to manufacture Portland cement was located at White Cliffs, on Little River. This plant was designed to use the Cretaceous chalk which occurs at that locality in abundance, and for mixture with the chalk clay was dredged from the river bottom lands. This plant was first operated in 1895, and has not been operated continuously nor is it operating at present. It is probable that the use of a better clay in place of the sandy material dredged from the river bottom would have been more suitable for Portland-cement manufacture.

CALIFORNIA.

There are no beds of limestone in California comparable in extent with the broad belts of limestone which are found in the Mississippi Valley States and in the Appalachian Valley. There are, however, numerous comparatively small areas scattered in various counties of the State. The principal deposits are as follows: San Diego County—Fine-grained chalklike limestone occurs near the Pacific coast, at Jamul. Orange County—Shell limestone is exposed at San Fernando and on the mesa at various places both toward Orange and toward San Juan. Los Angeles County—At the edge of the foothills near Mission San Fernando a shell limestone occurs in fairly large quantities. Kern County—Deposits of limestone occur at Techachapi and at other points in the vicinity. These have been largely used for making lime and for many years have furnished the bulk of the building-lime supply of California. The limestone is highly crystalline and satisfactory enough in chemical composition. San Benito County—A very pure limestone is reported to occur west of Hollister. Santa Cruz County—Deposits of limestone occur near the coast in the vicinity of Santa Cruz. These deposits are associated with shale and clay of good composition for making cement. Solano and Contra Costa Counties—Extensive deposits of travertine are exposed from Vallejo to Goodyear, Solano County, and from Mount Diablo to Pinole, Contra Costa County. These beds are now utilized for making Portland cement at Cowell and at Suisun. Sonoma County—

Limestone is reported at a point 6 miles northeast of Geyserville, o Little Sulphur Creek. This rock is reported to be a hard, compac drab limestone with inclusions of white microcrystalline limeston From its analysis it would appear to be satisfactory for a cemen material, but the size of the deposit is not known. Shasta County- Considerable limestone occurs in this county, especially in the coppe bearing district. A thick limestone of Triassic age occurs east Furnaceville, and a large mass of it forms Brock Mountain, on Squa Creek, and may be traced for many miles to the north. This rock generally pure, and at Brock Mountain is used for flux in the Bull Hill smelter. A belt of prominent limestone ridges and peaks extend north from near Lilienthals, by Gray Rock, the Fishery, and Hi Mountain, along the McCloud for many miles. This limestone i places is more than 1,000 feet thick. It is cut by numerous irregul dikes of igneous rocks, which locally interfere with quarrying. Th third belt of limestone occurs near Kennett, within a few miles of th railroad. This limestone is of Devonian age.

At present there are seven Portland cement companies operatin in California, as follows: The Pacific Portland Cement Co., at Cemen near Suisun; the California Portland Cement Co., at Colton; th Cowell Portland Cement Co., at Cowell; the Santa Cruz Portlan Cement Co., at Davenport; the Standard Portland Cement Co., a Napa Junction; the Riverside Portland Cement Co., at Riversid and the mill of the Los Angeles aqueduct at Monolith.

The plant of the Pacific company uses travertine and clay. Th California company uses crystalline limestone or marble obtaine from the ridge near the plant and clay shipped from a distanc The Cowell company uses travertine from a deposit near by, an adds shaly clay that is associated with the travertine. The Sant Cruz plant uses a nearly pure, highly crystalline limestone mixed wit clay and diatomaceous shale. The Standard company uses tw grades of limestone, one a relatively pure limestone carrying fro 85 to 90 per cent of lime carbonate, the other a much more claye limestone carrying 60 to 65 per cent or more of lime carbonat materials which are, therefore, closely similar to those used in th Lehigh district of Pennsylvania, although the California limeston are much softer than those of the Lehigh district. The Riversid plant uses a mixture of limestone and clay. The Portland cemen mill of the Los Angeles aqueduct[1] is owned by the city of Los Angele It is located at a point called Monolith, on the main line of th Southern Pacific Railroad, at a point about midway in the line the aqueduct. Three deposits of limestone are owned by the cit within 3 to 6 miles of the mill. A quarry has been opened on on of these deposits covering a tract of 120 acres 6 miles from the mil The quarry is located on a hillside about 800 feet above the base the valley, and the stone is delivered to a storage bin at the bas by means of an aerial tramway 4,700 feet long. A 3-foot gaug railroad carries the rock from the bin to the cement mill. Clay obtained about 1 mile from the mill. It is dredged from a broa depression partly filled by a small lake. The clay is delivered t the mill by an aerial tramway 5,800 feet long. Oil is used for kil fuel in all the California plants.

[1] Eng. Rec., The cement mill of the Los Angeles aqueduct: Sept. 17, 1910, pp. 330-331.

COLORADO.

The limestones of Colorado available for use as cement materials may conveniently be divided geographically and geologically into two groups. The first of these groups includes limestones mostly of Cretaceous age, which occur in the plains region of the eastern half of the State and in a narrow belt immediately east of the Front Range. The second group includes the limestones mostly of Carboniferous age, which lie west of the Front Range. At present it seems probable that the Cretaceous limestones are of greater industrial importance for cement manufacture than the Carboniferous rocks. The two limestone formations of greatest importance in the Cretaceous system are the Niobrara and the Greenhorn. The Niobrara limestone outcrops as a narrow but fairly continuous belt from the Wyoming line southward to Colorado Springs, passing just west of Fort Collins and Denver. South of Colorado Springs are two areas of Niobrara limestone, which occupy much of Pueblo, Otero, Huerfano, Las Animas, Bent, Prowers, Kiowa, and Cheyenne counties, the upper area of outcrop lying along Arkansas River, from near Florence to the Kansas line. The thickness of the Niobrara is about 400 feet, but calcareous shale makes up a considerable part of this thickness.

In central and western Colorado limestones of Mississippian age cover large areas. Analyses of limestones from a number of points in Garfield, Grand, Gunnison, Jefferson, Park, Pitkin, and Summit counties indicate that this limestone is sufficiently low in magnesia to be of probable value as a cement material.

Two Portland cement plants are in operation in Colorado, the Colorado Portland Cement Co., at Portland, and the United States Portland Cement Co., at Concrete. Both of these places are between Florence and Pueblo. Both plants use limestone, shaly argillaceous limestone, and clay, of Cretaceous age. Part of the shaly material is a cement rock. Coal is used as fuel. The New Castle Portland Cement Co. is reported to have built a small demonstrating plant at New Castle, in western Colorado, but no output has been reported from here.

CONNECTICUT.

There are many outcrops of limestone within the limits of the State of Connecticut, but few of them are large enough to justify the erection of a cement plant. In addition to this disadvantage most Connecticut limestones carry too high a percentage of magnesium carbonate to be valuable as Portland cement materials. The last statement is particularly true of the thick and extensive limestone beds of western Connecticut, which are extensively quarried and used for lime burning in the vicinity of Danbury and Canaan. No Portland cement plants are in existence in Connecticut.

DELAWARE.

The surface of the entire State of Delaware is composed of comparatively recent geologic formations, which are mostly unconsolidated sands and clays, with the exception of a relatively small area of pre-Cambrian and metamorphic rocks in the extreme northern part of the State. Such outcrops of crystalline limestone as have been found in this metamorphic area are too small to be considered from the standpoint of cement manufacture, and they are, in addition, rather high in magnesia.

FLORIDA.

Florida is largely underlain by beds of limestone of Tertiary and recent age, but these limestones are covered, for the most part, by comparatively thick deposits of sand and gravel. The limestone of the Vicksburg group, which corresponds to the upper part of the St. Stephens limestone of Alabama, is present in northern Florida, and where there are outcrops of these rocks the chemical composition appears to be favorable for the manufacture of Portland cement. Lack of fuel has heretofore been one of the chief hindrances to the consideration of Florida as a possible field for the manufacture of Portland cement, but recently consideration has been given to the possibility of utilizing the extensive peat deposits as a fuel supply. There are no Portland cement plants in this State.

GEORGIA.

Georgia is fairly well supplied with limestone, much of which is suitable for use in Portland cement manufacture. In the northwestern part of the State there are small areas of coal situated conveniently to areas of limestone. The four series of limestones that occur in Georgia, which contain material suitable for Portland cement manufacture, are (1) metamorphic limestone (or marble) of undetermined age; (2) Chickamauga limestone, of Ordovician age; (3) Bangor limestone, of Mississippian ("Lower Carboniferous") age; and (4) Cretaceous and Tertiary limestones (so-called "marls"). The highly crystalline or metamorphic limestones occur in northern Georgia, notably in Fannin, Gilmer, Pickens, and Cherokee counties. The Chickamauga limestone occurs also in northwestern Georgia, appearing as a series of long, narrow bands trending northeast and southwest parallel with the Appalachian uplift, and is a continuation of the limestone of northeastern Alabama. The Chickamauga is in many places a rather pure rock, carrying 90 to 95 per cent of lime carbonate, with generally less than 2 per cent of magnesium carbonate. The Bangor limestone occurs also in northwestern Georgia, and appears as a series of belts from one-half mile to nearly 2 miles in width, following closely the trend of Sand, Lookout, and Pigeon mountains, generally extending up on the flanks of these mountains as well as occupying parts of the intermediate valleys. The Bangor limestone in Georgia varies between 700 and 900 feet in thickness. It is for the most part a rather heavy-bedded blue limestone, commonly rather pure in lime and low in magnesia. Toward the top of the formation the limestone contains interbedded shale. The southeastern half of Georgia is surfaced by clay, gravel, and soft limestone of Cretaceous and Tertiary age. Several areas of soft limestone (commonly called marls in geologic and agricultural reports) are known to occur. One of these areas is a continuation of the Tertiary rocks in Alabama, described as the St. Stephens limestone. In Georgia this limestone occupies most of the counties of Decatur, Early, Calhoun, Miller, Baker, Mitchell, Dougherty, Lee, and Sumter. Analyses of this limestone show considerable percentages of silica, alumina, and iron oxide, but are at the same time remarkably low in magnesia.

Only one Portland cement plant is in operation in Georgia, that of the Southern States Portland Cement Co., located about one-half mile east of Rockmart, Polk County, Ga. The cement manufactured here is from a mixture of Ordovician shale and Chickamauga limestone, and is burned with coal. The Piedmont Portland Cement & Lime Co. is reported to be building a plant at Aragon.

IDAHO.

Small isolated areas of crystalline limestone or marble occur in the western portion of the State, but none of these have been found to be of very large extent. Marble is reported from the valleys of Snake and Clearwater rivers, also from points in Kootenai and Cassia counties. At Burley, Pebble, Orofino, Clifton, Marion, St. Anthony, Montpelier, Salmon, and Malad City limestone is quarried and burned into lime. In addition to this use some fluxing rock is quarried for use in the smelters. Thus far, however, no Portland cement plant has been started within the State.

ILLINOIS.

Low-magnesian limestones suitable for Portland cement manufacture occur in Illinois in (1) the Ordovician system; (2) the Mississippian series; and (3) the Pennsylvanian series ("Coal Measures").

Of the three divisions mentioned, the Ordovician and the Pennsylvanian limestones have been utilized as a source of Portland cement material, although the Mississippian limestone, considering its extent, thickness, and composition, would seem to be the most promising material of the three. Ordovician limestone underlies a large part of northern Illinois, but is covered by glacial drift in most places. It is very largely a high-magnesian rock, and therefore not available in many places as a source of Portland cement material. The Pennsylvanian ("Coal Measures") rocks cover most of Illinois south of a line drawn through Paxton, Wilmington, La Salle, Princeton, and Rock Island. The greater part of this series of rocks consists of shale and sandstone, but the presence of relatively thin beds of limestone is of interest, for it is from these beds that three of the five Portland cement plants draw their supply of raw material. The limestone beds occurring in the "Coal Measures" are usually thin but fairly persistent, although they do not outcrop at many points in the area. One series of beds is exposed near La Salle and Oglesby and shows a total thickness of 20 to 25 feet of limestone interbedded with shale and a little coal. This limestone, though generally high in clay impurities, is commonly low in magnesium carbonate.

Five cement plants are at present operating in Illinois. The Sandusky Portland Cement Co., at Dixon, uses a mixture of Ordovician limestone and Quaternary clay. The Marquette Cement Manufacturing Co. operates a plant at Dickinson, about 5 miles south of La Salle. The Chicago Portland Cement Co.'s plant is located at Oglesby, and the German-American Portland Cement Co.'s plant is located just east of La Salle. These three plants utilize limestone and shale and clay from the Pennsylvanian series. The plant of the Universal Portland Cement Co., at South Chicago, utilizes Pennsylvanian limestone from Fairmount, mixed with granulated blast furnace slag. Coal is the kiln fuel at all the Illinois plants. The erection of a plant near Golconda, to use limestone and shale of Mississippian age, is contemplated.

INDIANA.

Rocks in four of the geologic divisions that are represented in Indiana contain low-magnesia limestones and shales worthy of consideration as Portland cement materials. Beginning with the lowest, these divisions are (1) Cincinnatian limestone and shale; (2) Mississippian limestone; (3) Pennsylvanian limestone; and (4) Quaternary marl. The Cincinnatian series occurs in southeastern Indiana, occupying part or all of the counties of Union, Wayne, Fayette, Franklin, Dearborn, Ohio, Switzerland, Ripley, and Jefferson. This series is here made up of bluish, thin-bedded limestones, interbedded with soft, bluish-green, calcareous shales. Toward the top of the series massive, sandy limestone beds, brownish in color, occur locally in Clark and Jefferson counties. These beds are similar in composition to those in Kentucky and Ohio described in other parts of this pamphlet. Mississippian rocks occur in Indiana in a belt averaging 20 miles or more in width, extending from Ohio River in a northwesterly direction to the Indiana-Illinois line. Another area underlies Elkhart, La Grange, and St. Joseph counties in the extreme northern part of the State. The Mississippian rocks include several distinct divisions. Beginning at the lowest they are: (1) The "Knobstone" group, which consists of about 400 feet of shale and shaly sandstone. The shale is used at one of the Portland cement plants in the State. (2) The Harrodsburg limestone ranges from 30 to 100 feet thick, and consists mostly of limestone with a few thin beds of shale. (3) The Spergen limestone, known to the trade as Bedford oolitic stone, varies in thickness from 30 to nearly 90 feet, the greater thickness being in the area from Bedford to Salem. This rock is creamy white, soft when freshly quarried, hardens rapidly on exposure, and is of a high degree of purity. (4) The Mitchell limestone, which lies next above the Spergen limestone, and varies in thickness from 150 to 250 feet. It is a rather pure stone, but not so uniformly pure as the Spergen. (5) The Chester group, at the top of the Mississippian series, includes several beds of limestone interbedded with sandstone and shale. In view of the nearness of the thick and valuable Spergen and Mitchell limestones it seems improbable that the limestones of the Chester group will become of importance as cement material. Few of the Mississippian limestones carry over 4 per cent magnesium carbonate, and in most places they carry less than 1 per cent. In general they carry between 93 and 98 per cent calcium carbonate. The limestone beds in the Pennsylvanian series are similar in composition to those in adjacent portions of Illinois, described on another page. The Quaternary marls occur in deposits of sufficient size to justify the erection of Portland cement plants only in the three northern tiers of counties. The largest deposit so far reported is in Lake Wawasee. It contains about 1,700 acres. The thickest deposit reported is 45 feet, in Turkey Lake, La Grange County. The Indiana department of geology and natural resources has described 33 deposits of marl in northern Indiana considered to be of sufficient size to supply a cement plant producing 500 barrels a day for 15 years. The marls generally range well within the limit of magnesium carbonate, carry 82 to 93 per cent lime carbonate, and generally below 5 per cent silica.

In 1910 five plants reported production of Portland cement. The Universal Portland Cement Co., at Buffington, utilizes limestone of Pennsylvanian age from Fairmount, Ill., and granulated slag from blast furnaces at South Chicago, Ill., and Gary, Ind. The Lehigh Portland Cement Co., at Mitchell, utilizes limestone of Mississippian age, and shale. The Louisville Cement Co., at Speeds, utilizes limestone, shale, and cement rock. The Wabash Portland Cement Co., at Stroh, and the Sandusky Portland Cement Co., at Syracuse, both utilize marl and clay. All the plants use coal as kiln fuel. In addition to these plants there was in operation for several years previous to 1910 the plant of the United States Portland Cement Co. near Bedford. This plant used the Mitchell limestone and shale quarried at Brownstown.

IOWA.

The calcareous constituent of cement may be obtained from three classes of materials in Iowa, namely, limestone, chalk, and marl. Shale and clay are afforded by nearly all the indurated formations in the State. Nonmagnesian limestone beds are found in Iowa in the Ordovician, the Devonian, and the Carboniferous. Limestones earlier than the Ordovician are generally highly magnesian. Those of the Ordovician are predominantly magnesian except the Platteville limestone of the northeastern part of the State. This rock occupies portions of Dubuque, Clayton, Fayette, Winneshiek, and Allamakee counties. The strata included in the Platteville limestone are in the main either nonmagnesian or only slightly magnesian. In composition, as in geologic position, they are nearly equivalent to the famous cement rock of the Lehigh Valley. Next above the Ordovician rocks lie the Devonian limestones, and in Iowa there are beds representative of both Upper and Middle Devonian. The Upper Devonian includes the State quarry limestone of the Iowa State survey in Johnson County, the Sweetland Creek shale in Muscatine County, and the Lime Creek shale. The larger portion of the Iowa Devonian section, however, belongs to the Middle Devonian, which is represented over large areas by the Cedar Valley and the Wapsipinicon limestones. The Lime Creek and the Wapsipinicon include some magnesian rock and the Wapsipinicon also includes some shale, but in general the Devonian limestones of Iowa are characteristically free from magnesia. Carboniferous rocks also underlie a large portion of Iowa. They include limestone, sandstone, shale, and coal. The Carboniferous limestone is rarely magnesian, and is excellently situated with reference to fuel and transportation facilities. Both the Mississippian and the Pennsylvanian series of the Carboniferous system are represented in this State. In the Mississippian series are included the Kinderhook group, the Osage group, and the "St. Louis limestone," each containing important limestone beds. The Pennsylvanian includes the Des Moines group ("Lower Coal Measures") and the Missouri group ("Upper Coal Measures"). The Des Moines group includes most of the coal beds worked in the State, but very little limestone. The beds outcrop in a broad belt between the limestones of the Mississippian series to the east and the calcareous shale and thin limestone of the Missouri group. The

Kinderhook group is exposed to a thickness of about 60 feet at Burlington. It consists principally of soft, argillaceous shale. Above the shale are about 50 feet of sandstone and limestone. In Marshall County there is extensive development of this limestone. The limestone has been quarried at Legrand and its analysis shows that a considerable portion of it is suitable for cement manufacture. The Osage group includes formations which are widely known as the Keokuk and Burlington limestones. The group consists for the most part of coarse, white, nonmagnesian, crinoidal limestone, having chert in nodules along the bedding planes. The chert nodules are objectionable in cement manufacture. These beds are best exposed in Lee and Des Moines counties, but occupy portions of Louisa, Washington, Henry, and other counties in the southeastern part of the State. Rock from this group at Burlington contains but little chert, shows a high percentage of calcium carbonate, and but little magnesia. The so-called St. Louis limestone of Iowa is one of the most widely distributed geologic divisions in the State. On account of its relation to the coal beds it has been carefully mapped and extensively studied by the Iowa survey. In central Iowa it includes three minor divisions, which have been called by Bain the Pella, the Verdi, and the Springvale beds. The first named are the most important. Samples of limestone from Ottumwa, Pella, Tracy, Oskaloosa, and Humboldt have been analyzed and found to run well within the limits of magnesia, and to contain about 95 per cent of calcium carbonate. Analyses of limestone and interbedded shale from the mouth of Lizard Creek, Webster County, have been made with favorable results, and a cement has been made from a combination of this shale and limestone, tests of which showed satisfactory color, strength, and setting properties. The Des Moines group contains very little limestone, and near Rathbun and Clarkdale one of the limestone beds reaches a thickness of 10 to 15 feet. Because of its close association with clay and a good coal bed it is perhaps of value. Analyses show that it is practically free from magnesia and carries from 74 to 93 per cent of calcium carbonate. Southwestern Iowa is underlain by rocks of the Missouri group, consisting mainly of shale and limestone. The latter are almost entirely free from magnesia and chert, are in places somewhat earthy, and are easily ground. They should, accordingly, be well adapted to cement manufacture. These rocks are quarried at various points, particularly Earlham, Winterset, and Peru, and the same ledges have been recognized as far south as Decatur County on the Missouri boundary.

The Cretaceous deposits which cover the western third of Iowa include important bodies of chalk. With but two unimportant exceptions, outcrops of the chalk beds are confined to the valley of Big Sioux River, between Sioux City and Hawarden. The chalk forms prominent bluffs at intervals, and may well be seen near Westfield, Akron, and Hawarden. It is the equivalent of the "Oyster Shell Rim" of the Black Hills, or the Greenhorn limestone. The thickness is generally from 30 to 50 feet. The chalk contains almost no magnesia, but in places contains enough or more than enough silica and alumina to make a good cement mixture. In all cases, however, excellent clays occur immediately above or below the chalk. Both materials are soft and grind easily.

Calcareous marl occurs in lakes which are characteristic of the area covered by the glacial drift of Wisconsin age. The north-central portion of Iowa is covered by this drift and is dotted with small, shallow lakes resembling in appearance and origin those of Michigan. Small beds of marl have been discovered in these lakes, but thus far none have proved of importance.

It is thus evident that there are many places in Iowa at which materials suitable for Portland cement manufacture are available. The marls have not yet been proved to be important. Suitable chalk or soft limestone may be found along Big Sioux River, north of Sioux City. The question of the advisability of establishing a plant in this district must be determined by consideration of manufacturing costs, of market, and of transportation facilities. Within the broad areas of limestone there are really only a limited number of outcrops, because of the generally heavy cover of drift. Even where deposits occur the overburden is in many places so thick as to entail prohibitive stripping costs. The best situations are, therefore, in the valleys near the junction of streams. Fortunately, many railway lines follow valley routes. Coal mines are so situated as to afford cheap fuel in most of the hard limestone localities. Iowa coal, although not of the highest grade, is fairly well adapted to cement manufacture.

There are two Portland cement plants at present operating in the State of Iowa, and one under construction. The Northwestern States Portland Cement Co. has been operating for several years at Mason City, utilizing the Cedar Valley limestone of the Devonian, and clay shale from the Lime Creek shale of the Devonian. The Iowa Portland Cement Co., at Des Moines, began manufacturing cement in 1910. The materials utilized are limestone and shale from the Missouri group of the Pennsylvanian series. The Lehigh Portland Cement Co. is reported to be constructing a plant at Mason City, which will use materials similar to those of the Northwestern States plant. The Iowa plants burn their cement with coal.

KANSAS.

Limestone beds belonging to four geologic divisions offer possibilities for cement manufacture in Kansas. Beginning with the lowest they are as follows: (1) Mississippian series; (2) Pennsylvanian series ("Coal Measures"); (3) Permian series; and (4) Cretaceous system. Of these four divisions the Pennsylvanian rocks are at present of the greatest importance in the cement industry, although the chalky limestone of the Cretaceous system is also suitable for cement manufacture.

The Mississippian rocks occur only in one small area in the extreme southeastern corner of Kansas, about 30 square miles in Cherokee County being covered by rocks of this age. This series is composed of limestone with interbedded chert and a few beds of shale. The limestone is usually heavy bedded and low in magnesia. It is the rock that is extensively quarried at Carthage and other points in Missouri. Pennsylvanian rocks outcrop in the three eastern tiers of counties, and in parts of counties in the fourth tier. Although made up mostly of shale and sandstone, the series includes a number of beds of limestone. These limestones are of importance as Portland cement materials because of their usual purity, their proximity to satisfactory shale and to transportation routes, and above all because they occur in many places in Kansas within or in proximity to the natural gas field. Permian rocks occur west of the Pennsylvanian rocks, and include a few beds of limestone. The chalk and chalky limestones of the Cretaceous occur in western Kansas. The principal outcrops are in Jewell, Smith, Phillips, Rooks, Osborne, Graham, Ellis, Trego, Gove, Logan, Ness, Lane, and Finney counties, and the same rocks are exposed in southern Nebraska and along Republican River.

Kansas ranks fourth among the States as a producer of Portland cement, being exceeded in importance only by Pennsylvania, Indiana, and California. The production of cement came from 10 plants, all except one of which utilized a mixture of Carboniferous limestone and shale, the exception being the plant of the U. S. Portland Cement Co., at Yocemento, which operates on Cretaceous chalky limestone and shale. In southeastern Kansas, where the industry is mainly concentrated, are the United Kansas Portland Cement Co., with plants at Iola, Neodesha, and Lehunt (near Independence); the Iola Portland Cement Co., at Iola; the Western States Portland Cement Co., at Independence; the Fredonia Portland Cement Co., at Fredonia; the Monarch Portland Cement Co., at Humboldt; the Altoona Portland Cement Co., at Altoona; the Ash Grove Lime & Portland Cement Co., at Chanute; and the Great Western Portland Cement Co., at Mildred. In the northern part of the State the Bonner Brand Portland Cement Co. is located at Bonner Springs, about 17 miles west of Kansas City. There are a few more Portland cement plants in various stages of promotion, but nothing can be said as to the probability of their being built. All of the plants that are in the gas belt used natural gas for fuel originally. Three plants, including the one at Yocemento, are using oil exclusively, others are now using oil with gas, and the rest are preparing to use oil in case the natural gas supply becomes scarcer.

KENTUCKY.

Limestones prevailingly low in magnesia and otherwise satisfactory as cement materials occur in Kentucky in four geologic divisions. Beginning with the lowest, they are: (1) Ordovician limestones of Trenton and Stones River ages; (2) Ordovician limestones of Cincinnatian age; (3) Mississippian ("Lower Carboniferous") limestone; and (4) Pennsylvanian ("Coal Measures") limestone. The limestones of Trenton and Stones River ages occupy much of the counties of Franklin, Scott, Woodford, Fayette, and Jessamine, and smaller portions of Boyle, Clark, Mercer, Owen, Henry, and Anderson. They are generally low in magnesia, and carry from 90 to 95 per cent of lime carbonate. They represent a combined thickness of about 700 feet of solid, chiefly nonmagnesian limestone. Limestone of Trenton age outcrops in a narrow strip along Ohio River in Kenton and Campbell Counties. The limestone of Trenton age along Ohio River runs higher in silicia than in central Kentucky, but the magnesium carbonate generally is less than 2 per cent.

The shale and limestone which make up the Cincinnatian series in Kentucky occupy most of the north-central portion of the State. These rocks consist of dark-blue argillaceous thin-bedded limestone, with much interbedded shale. The limestone usually is in satisfactory condition for cement material, but the shale is in places sandy, especially in the southern and western parts of the area. The limestone beds of Mississippian age are commonly low in magnesia, and in most of the area covered by them in Kentucky they are also high in lime carbonate. In the southern part of the State interbedded layers of chert become common until the lower part of the series becomes too siliceous to be of much promise as a source of Portland cement material. In this series are two horizons or beds, both oolitic, that are important. The first, which is equivalent to the Spergen limestone of Indiana, forms a broad strip passing through Meade, Hardin, La Rue, Barren, Warren, Todd, Christian, and Trigg counties. The second is the Ste. Genevieve limestone, which is limited to Christian, Caldwell, Crittenden, and Livingston counties in western Kentucky. Between the first strip and the border of the western Kenutcky coal field there is, first, a broad strip of St. Louis limestone, which is usually too siliceous and too magnesian for use in making Portland cement, and near, or just outside of the coal field the limestone, shale, and sandstone of the Chester group occur. The Chester contains several beds of apparently promising limestone closely associated with beds of shale. At Stanton, Powell County, the Newman limestone (Mississippian) outcrops in a high bluff near the Lexington & Eastern Railway and might be utilized in connection with the alluvial clay forming the terrace of Red River.[1] A number of limestone beds are interbedded with the Pennsylvanian shale and sandstone. These limestone beds are usually low in magnesia, and rarely carry more than 80 to 90 per cent of lime carbonate. Compared with the thick series of limestones, they are so thin that they would be of little importance were it not for their advantageous location near supplies of fuel.

Only one Portland cement plant has thus far been built in Kentucky. It is located at Kosmosdale and operated by the Kosmos Portland Cement Co. Limestone and clay are the raw materials used, and are burned with coal. Several other Portland cement plants are understood to be in different stages of promotion in this State.

LOUISIANA.

The great chalk formations which occur in the other Gulf States of Alabama, Florida, Mississippi, and Texas fail to occur in Louisiana except as isolated outcrops. The State is, therefore, practically devoid of limestone, and can hardly be considered as a possible future producer of Portland cement. Such outcrops as do occur are confined chiefly to the Cretaceous. Limestone from Winnfield is described as a highly crystalline, blue and white banded stone, full of cracks, pockets, and other flaws, which render it useless as an ornamental or building stone. The stone has been utilized for making lime, and analyses of it show it to possess a high degree of purity.

MAINE.

Under present conditions as to fuel supply and transportation, the only limestone deposits in Maine on which a Portland cement industry could be based are those which outcrop along or near the Atlantic

[1] Gardner, J. H., Rept. of Progress, for 1904–5, Kentucky Geol. Survey, pp. 18–20.

coast. Of these by far the most promising are the limestones which are extensively utilized for lime burning in the Rockland-Rockport region of Knox County. Numerous other areas of limestone more or less extensive are known to occur in various parts of the State. Most of these outcrops, however, are located far from fuel supplies and cement markets. The limestone in the Rockland-Rockport area forms a long, narrow, somewhat irregular strip, trending northeast and southwest. It is surrounded by quartz rocks and schist. The longest continuous belt is somewhat over 5 miles in length. In some places it has a width of nearly a mile. All of the limestone in this district is highly crystalline. Two quite distinct types of stone have been found. One type is highly magnesian, and in many places approaches the composition of dolomite. The other type is characteristically low in magnesia, and rarely carries over 3 per cent of that constituent. The rocks are steeply tilted and closely folded. Extensive deposits of marine clays occur along the lowlands of the coastal region in the same general area which contains the low magnesian limestone just referred to. Limestone beds of considerable extent occur also near Islesboro. A specimen from this locality showed on analysis that it was a very pure limestone, low in magnesia.

MARYLAND.

Limestone beds of several geologic divisions have been found in Maryland to be of sufficient extent and purity to be of commercial importance as Portland cement material. Beginning with the lowest rocks they are as follows: (1) Metamorphic limestone, probably of Cambrian and Ordovician age; (2) limestones of the Shenandoah group, of Cambrian and Ordovician age; (3) limestones of the Cayuga group, of Silurian age; (4) the Helderberg limestone, of Devonian age; and (5) the Greenbrier limestone, of Mississippian age. In addition to the rocks above mentioned, a number of other limestone-bearing formations occur in Maryland, but they are normally too high in magnesia, too siliceous, or otherwise not well adapted to use in Portland cement manufacture. The Tertiary shell marls of the Coastal Plain, for example, are here too low in lime carbonate to be seriously considered in this connection.

In the Piedmont area of eastern Maryland crystalline limestones and marbles occur in a number of places. The crystalline limestone is extensive in Carroll, Baltimore, and Howard counties, and less important in Frederick County. In composition these metamorphic rocks vary considerably. The Cockeysville marble, for example, is highly magnesian, while the metamorphic limestone from Texas and Union Bridge is likely to be as low in magnesia as the best unaltered "Trenton" limestone of this region. Limestones of the Shenandoah group occupy three principal areas in Maryland. Two of these areas are in Washington County and one in Frederick County. The westernmost area crosses central Washington County as a comparatively narrow belt, but the central limestone belt covers almost the entire eastern third of Washington County. It underlies the Hagerstown Valley, Antietam Creek running down the middle of the valley. Hagerstown and Sharpsburg are located near the middle of the belt. Blue Mountain, Edgemont, and Weverton lie near its eastern edge, and Williamsport, Salisbury, and Mangansville are on or near the western border of this belt. The third and easternmost area is in the eastern part of Frederick County, along the valley of Monocacy River. The towns of Frederick, Adamstown, Woodsboro, and Walkersville are located in this area of limestone. Both the Cayuga group and the Helderberg limestone outcrop in Maryland in a number of parallel belts. Most of these are in the west-central part of Allegany County, though several occur in western Washington County. The Cayuga group includes one or more rather thin but very persistent beds of low magnesia limestone. These beds are also high in clayey matter, so that in places they approximate quite closely the composition of the cement rock of the Lehigh district of Pennsylvania. Samples of the rock have been analyzed from Hancock and Round Top, Washington County, and from Corriganville, Cumberland, Potomac, and Dawson, Allegany County, and show a range in magnesia from less than 1 per cent to about 6 per cent. The majority however, are lower than 3 per cent in magnesia. Some of the rocks are high in lime and low in silica and alumina, but most of them run high in silica. The Helderberg limestone is, as a rule, low in magnesia, and carries between 40 and 52 per cent of lime, with from 3 to 30 per cent of silica. The Greenbrier limestone outcrops only in Allegany and Garrett counties. A single belt passes through the western part of Allegany County, extending about S. 30° W., and crosses Potomac River at a point between Western Port, Md., and Keyser, W. Va. In Garrett County the Greenbrier is better shown, appearing in six belts or areas. The Greenbrier limestone, where best developed in Maryland, consists of three distinct members. The lowest is a series of limestone beds, siliceous near the base and ranging from 27 to 46 feet in thickness. The middle member consists largely of shale and thin sandstone, and varies from 88 to 98 feet in thickness. The upper member consists almost entirely of very pure limestone, and is from 65 to 85 feet thick. These beds have been extensively used for flux and for lime burning, and their range in composition is fairly well known. They are commonly low in magnesium carbonate, though in places a bed will show a prohibitive percentage of that ingredient. In places they carry sufficient silica, alumina, and iron oxide to approximate the composition of the cement rock of the Lehigh district, but usually it will be necessary to add a considerable proportion of clay or shale in order to bring a mixture up to correct composition for Portland cement. Certain Carboniferous shale beds from near Corinth, Garrett County, have been considered in connection with the Greenbrier limestone as possible Portland cement material, but the percentage of iron oxide is high, so that the ratio of silica to alumina and iron oxide commonly falls below 2, whereas it should be between 2.5 and 3 in order to make an ideal Portland cement shale.

At present there is one Portland cement plant in operation in Maryland, that of the Security Cement & Lime Co., at Security, near Hagerstown. The Tidewater Portland Cement Co. is constructing a plant at Union Bridge, which is expected to be in operation in 1911. The raw materials used at Security are limestone and shale. The limestone is obtained from low-magnesia beds of the Conococheague limestone (of Cambrian age, and one of the formations of the Shenandoah group), and is quarried in the immediate vicinity of the plant. The Martinsburg shale, of Ordovician age, is also used, and is obtained from near Pinesburg. Coal is used as fuel. The raw materials available at Union Bridge are metamorphosed and highly crystalline limestone common to the Piedmont district, and slaty rock reported to be of volcanic origin.

MASSACHUSETTS.

In western Massachusetts extensive quarries are operated for both marble and lime. The rock is of Cambrian and Ordovician age. At many points it is highly magnesian. No shale occurs near this limestone area, and the glacial clays generally contain too much sand and gravel to be available for Portland cement manufacture. No normal Portland cement industry has yet been established in Massachusetts, but the Berkshire White Portland Cement Co. established several years ago a small plant at Clayton, Berkshire County, and up to 1910 was engaged in manufacturing white Portland cement from pure crystalline limestone and clay, burning the mixture with oil. During 1910 this plant was idle.

MICHIGAN.

Michigan possesses extensive supplies of materials necessary for the production of Portland cement. Two classes of material have been drawn upon for the lime necessary for cement manufacture, namely, hard limestone and marl. Of the various limestone formations, at least three are apparently suitable for Portland cement, namely, the Dundee limestone, limestone of the Traverse formation, and limestone of the Michigan formation. The Dundee limestone occurs at the base of the Devonian system and, although generally concealed beneath glacial drift and surface deposits, outcrops in a belt about 2 to 9 miles wide, trending northeast and southwest, and crossing Wayne, Monroe, and Lenawee counties in the southeastern corner of the State. The same formation occurs also at the extreme northern end of the southern peninsula and on Mackinac and neighboring islands, as well as in adjacent portions of the northern peninsula. The purest layer of limestone in the Dundee thus far noted is quarried extensively at Sibley and Bellevue, Wayne County, and is used in the manufacture of sodium bicarbonate, soda ash, and caustic soda near Detroit. The finely powdered calcium carbonate resulting as a by-product from the manufacture of caustic soda has been used for making Portland cement at Wyandotte. This same limestone on account of its great purity is also used in the manufacture of beet sugar. The Dundee formation contains also several beds of limestone which carry too high a percentage of magnesia to permit their use in making Portland cement under the standards now required in the composition of the finished product. The bed at the Sibley quarries is about 9 feet thick. This rock is quarried also 2 miles northeast of Dundee, in Monroe County, and at a great many other places. The rocks next above the Dundee limestone belong to the Traverse formation. They are also of Devonian age, and they form a belt about 2 miles wide which crosses Wayne and Monroe counties, but are for the most part concealed. They also form a broad area which crosses the northern end of the southern peninsula from Alpena, on Lake Huron, to Frankfort, on Lake Michigan. These beds are extensively quarried at Alpena. The main part of this limestone is of great purity, carrying 95 to 99 per cent calcium carbonate, and is used for making caustic soda, Portland cement, and for flux. At the top are beds of magnesian limestone, some of which is used in the manufacture of paper. The Michigan formation is of Mississippian age. It carries limestone principally in the upper part of the formation, and is for the most part concealed by glacial deposits. Outcrops of this limestone occur at Bay Port and Sebewaing, Huron County; on the Charity Islands; at Bellevue, Eaton County; and near Portage River, 5 or 6 miles north of Jackson. It has been quarried at Bay Port, Bellevue, and near Jackson for use in making lime and in beet-sugar manufacture. Some layers in the Michigan formation are high in magnesia, but such outcrops of the formation as occur near deposits of clay or shale and are suitably situated with reference to transportation facilities are worthy of examination, since they are likely to be of suitable composition for Portland cement.

Marl, which constitutes fully as important a cement material as limestone in Michigan, occurs principally in the basins of existing lakes, and frequently extends beyond the present water margin and underlies bordering swamps. Marl beds are present also in many instances beneath beds of peat and muck upon which tamarack and other trees are growing. The presence of marl beds about the borders of existing lakes and at an elevation in some cases of 10 to 15 feet above their surfaces, shows that the lakes have been lowered, usually by the cutting down of their outlets since the marl began to form. In extent the marl beds vary from a few acres to several hundred acres each. In depth they range from a few inches to over 35 feet, as has been demonstrated by borings, and in some instances are known to reach depths as great as 70 feet. The bottoms of the lakes containing the marl are usually sandy, so that the marl can not always be dredged clear to the bottom of the deposit. Analyses of a large number of marl deposits show that in few cases magnesia runs in excess of the allowable limit. Lime carbonate runs generally between 85 and 94 per cent, although certain analyses show as low as 77 per cent and others as high as 97 per cent of calcium carbonate. Silica, alumina, and iron are relatively low, the iron and the alumina rarely running higher than 3 per cent and the silica generally not more than 3 per cent, although this substance is more variable than the other constituents on account of sandy impurities becoming mixed with the marl.

Surface clay as well as shale from the Traverse and the Coldwater formations have been used with marl in Portland cement plants in Michigan. In addition, shales from the Antrim and the Saginaw formations are regarded as possibly available.

In 1910 there were 12 plants producing Portland cement in Michigan. At Alpena the Huron Portland Cement Co. utilizes local limestone of the Traverse formation, and shale, also of Devonian age, from 9 miles west of Alpena. Limestone from the quarry at Alpena is also shipped by boat to the plant of the Hecla Portland Cement Co., at Bay City, and to the works of the Michigan Alkali Co., near Detroit. The plant of the Hecla Co., just mentioned, mixes clay with the limestone from the Traverse formation. The Burt Portland Cement Co., at Bellevue, uses limestone and clay; the Newago Portland Cement Co., at Newago, originally built to use marl, now uses limestone and clay; the Elk Cement & Lime Co., at Elk Rapids, uses limestone and shale; the Wyandotte Portland Cement Co., at Wyandotte, uses limestone and clay; and the following plants all use marl and clay: The Peninsular Portland Cement Co., at Cement City; the Wolverine Portland Cement Co., at Quincy and Coldwater; the New Ætna Portland Cement Co., at Fenton; the Omega Portland Cement Co., at Mosherville, and the Peerless Portland Cement Co., at Union City.

In addition to these active plants, the Michigan Portland Cement Co. is rebuilding on the site of the former Millen Portland Cement Co., at Chelsea, and expects to begin manufacturing in 1911. The New Bronson Portland Cement Co., at Bronson, is undergoing reorganization; the plant of the Egyptian Portland Cement Co., at Fenton, is reported to be idle, as well as that of the Alpena Portland Cement Co., at Alpena. All the inactive plants used marl and clay exclusively, except the Alpena plant, which used also limestone from the Traverse formation. Coal is used as fuel in all the Michigan plants.

MINNESOTA.

Only one limestone outcrops in Minnesota that is sufficiently low in magnesium carbonate to be available as a Portland cement material. This rock is of Ordovician age and corresponds closely with the Platteville limestone of southwestern Wisconsin and eastern Iowa. This formation is well developed in southern Minnesota, particularly in the vicinity of Wykoff, Spring Valley, and Faribault. The pure limestone beds in these localities are underlain and overlain in places by shale which might prove available for use in mixture. In addition to the rather limited supplies of natural raw material, another and more important raw material will soon come into existence in this State in the form of supplies of slag, which will be available at the blast furnaces which are planned to be built at Duluth.

MISSISSIPPI.

Several large areas of limestone occur in Mississippi, and at least one of these areas is well located with respect to transportation routes. Part of this area has access to excellent fuel supplies at low cost. The available limestones of the State may be grouped and described under the following heads, the first being most promising as a possible basis of cement industry: (1) Tertiary (Vicksburg limestone) of central Mississippi; (2) Cretaceous (Selma chalk or "Rotten limestone") of eastern Mississippi; and (3) Devonian and Mississippian limestones of northeastern Mississippi. The Vicksburg limestone is equivalent to the upper part of the St. Stephens limestone of Alabama. It crosses the State in a direction a little north of west from near Waynesboro to the vicinity of Vicksburg. The outcrop generally shows as a low ridge, with a gentle southern slope and a sharp declivity toward the north, rendering it easy to trace the limestone and affording many favorable quarrying sites. Portions of Wayne, Clark, Jasper, Smith, Newton, Scott, Jackson, Madison, Hinds, Warren, and Yazoo counties are underlain by this limestone. The Vicksburg consists of alternating beds of fine-grained magnesian limestone and highly calcareous marl beds, more or less indurated in places. The individual beds of limestone range from 1 to 4 feet thick, and the marl beds reach thicknesses of 3 feet in places. In a measured section at Vicksburg there is a total of 17 feet 5 inches of hard limestone and 16 feet 8 inches of marl and clay. In such a section as this the marl and the limestone must of necessity be used together. A large number of analyses of marl from different localities show that it contains no large amounts of injurious properties and that it can probably be used for cement as it comes from the quarry. The marl and clay supply the silica and alumina for Portland cement and are therefore as valuable as the limestone. By taking a general average of the analyses of samples of limestone and interbedded marl it is possible to construct a suitable mixture for Portland cement without the addition of other materials. In the central and eastern parts of the State the Vicksburg formation is more homogeneous than it is in the western area. In Smith County the Vicksburg is a soft, porous limestone known as the "chimney rock."

The Selma chalk ("Rotten limestone") consists of a thick series of chalk, chalky limestone, and more or less limy clay. This belt enters Mississippi from Alabama and underlies portions of Kemper, Noxubee, Lowndes, Oktibbeha, Clay, Monroe, Chickasaw, Pontotoc, Lee, Prentiss, Tippah, and Alcorn counties, extending northward into McNairy County, Tenn. The width of the belt is generally from 10 to 25 miles. The chalk measured about 700 feet thick in a well at Starkville, Oktibbeha County. As the belt turns northward toward Tennessee, the Selma chalk decreases in thickness and limestone beds become fewer and thinner until in Tennessee the Selma consists of a thin series of somewhat calcareous clay beds, with only a few beds of chalk. Numerous analyses have been made of the Selma chalk, and nearly all of them show a considerable percentage of silica, the range being generally from 8 to 25 per cent. The alumina and iron oxide range generally from 5 to 7 per cent and the calcium carbonate from 70 to 85 per cent. Occasionally a sample of rock is found which is nearly pure calcium carbonate. The magnesium carbonate appears to be invariably well within the limits permitted by Portland cement manufacture. Where an addition of clay is required to make a good cement mixture there are generally two possible sources of clay: (1) Residual clay from weathered Selma chalk. This clay is generally in close proximity to the chalk beds, and for that reason would be the most available material. (2) A series of clays known as the Porters Creek clay, joins the Selma chalk belt on the west and in places overlies the chalk deposits. The Porters Creek clay is usually excellent for use with the Selma chalk as a cement mixture.

The Devonian and the Mississippian rocks outcrop in a small area in the extreme northeastern corner of Mississippi in the counties of Itawamba and Tishomingo. They include shale, thin sandstone, and limestone. Limestone occurs in rocks of both ages, and is commonly low in magnesia and otherwise suitable for use as Portland cement material. One section of limestone of Devonian age on Yellow Creek was found to be about 150 feet thick, but it is probable that the total thickness of limestone of this age in this area may reach 500 feet or more. This limestone is commonly high in silica. In the Mississippian rocks of this area are beds of oolitic limestone, which are similar in character, composition, and geologic age to the well-known oolitic limestone of the Bedford, Ind., district. Analyses of limestone from Tishomingo County showed from 47 to 53 per cent of calcium oxide, from 1.6 to 11 per cent of silica, from 2 to 8 per cent of alumina, and less than 0.4 per cent of magnesia.

No cement plants, either Portland or natural, have yet been erected in Mississippi. It is probable, however, that the favorable composition and location of the beds of Vicksburg limestone will sooner or later attract serious attention.

MISSOURI.

The limestones in Missouri which are best adapted for use as Portland cement materials are mostly of Ordovician and Mississippian ages. Certain Silurian formations, however, include limestone beds sufficiently low in magnesia to be worthy of investigation in this connection, and some thin beds of limestone which occur in the Pennsylvanian series are also of value as cement materials. Ordovician limestone occurs in two separate areas in eastern Missouri, both of which are well located with regard to railroad and water transportation. The smaller area lies in Ralls, Pike, and Lincoln counties, outcropping as a belt 1 to 3 miles wide from near Spalding, southeastward to Mississippi River about 10 miles south of Hannibal, thence northward to within a few miles of Edgwood, Pike County. The second and larger belt commences in southern Callaway County and runs eastward parallel to and a few miles north of Missouri River, through Montgomery, Warren, and St. Charles counties. This belt reaches Missouri River at Hamburg, and turns southward through St. Louis and Jefferson counties reaching Mississippi River at Kimmswick. From this point south to Cape Girardeau the limestone follows the river closely, appearing either in the bluffs or a few miles west of them. Two formations represent the Ordovician in this locality, the Kimmswick and the Plattin limestones. These limestones are commonly low in magnesia, although some beds show 5 to 10 per cent of magnesium carbonate. Overlying the Kimmswick limestone is a shale of late Ordovician age, which carries in places a large percentage of lime. This shale has been found in places suitable for mixture with the Ordovician limestone for making Portland cement.

Mississippian limestones are surface formations over almost one-fourth of the area of Missouri. The three most prominent areas of outcrop are along Mississippi and Missouri rivers, and in southwestern Missouri. An extensive and important area of Mississippian limestone occurs in northeastern and eastern Missouri, along Mississippi River. This belt covers the eastern half of Clark, nearly all of Lewis, Knox, Shelby, Marion, Monroe, Ralls, Pike, Lincoln, and St. Charles counties, and portions of Montgomery, Warren, St. Louis, Jefferson, Ste. Genevieve, and Perry counties. The limestone beds appear continuously in the river bluffs or in the stream cuts along the west bank of the Mississippi from the Iowa State line to a point about 10 miles south of Hannibal. Here the Mississippian limestone leaves the river for some distance, Silurian rocks appearing in the bluffs from below Saverton to Cap au Gris. At Cap au Gris limestone beds again appear and form the river bluffs as far south as Kimmswick in Jefferson County. Ordovician rocks then appear on the river bank for about 12 miles, but about 5 miles below Crystal City the Mississippian limestone reappears in the bluffs and shows almost continuously to a point less than a mile south of Wittenberg, Perry County, where it finally disappears. Another area of Mississippian limestone is on and near Missouri River. In this area limestone covers most of Pettis, Saline, and Cooper counties on the south side of the river, and outcrops continuously along the north bank from Miami Station, Carroll County, through southern Howard County to below Rocheport, Boone County. The belt then leaves Missouri River and extends eastward, joining the Mississippi belt just described. In southwestern Missouri Mississippian limestone forms the surface of the greater part of McDonald, Newton, Jasper, Barry, Lawrence, Stone, Christian, Greene, Dade, and Cedar counties, and also the southwestern half of Polk and smaller portions of Barton, St. Clair, Hickory, and Benton counties. This extensive area is traversed by numerous railroads. The Mississippian rocks of Missouri include several thick limestone formations, with at least one thick series of shales. The limestone beds are almost invariably good Portland cement materials, and the shale is generally of the proper composition to mix with the limestone.

Almost all of northern and western Missouri is covered by the Pennsylvanian series ("Coal Measures"), which overlies the Mississippian series just described. The Pennsylvanian series consists of thick beds of shale and sandstone, with a few thin beds of limestone and numerous coal seams. The limestone is generally high in silica and low in magnesia. Its principal advantage is that it is found in close proximity to coal beds and to shale.

Four plants produced Portland cement in Missouri in 1910. Two of these plants, the St. Louis Portland Cement Co., at Prospect Hill, north of St. Louis, and the Kansas City Portland Cement Co., at Cement City, east of Kansas City, are owned by the Union Sand & Material Co., of St. Louis. The Hannibal plant of the Atlas Portland Cement Co., comprising two mills, and the plant of the Continental Portland Cement Co., at Continental, are the others. In addition to these, at least one plant is in a prospective stage, and in 1911 the Cape Girardeau Portland Cement Co. is reported to have begun operations. The St. Louis plant uses Mississippian limestone and shale of the Des Moines group of the Pennsylvanian. The Hannibal plant uses Burlington limestone and Hannibal shale, both of Mississippian age. The Kansas City plant uses limestone and shale of Pennsylvanian age. The Continental plant uses St. Louis limestone (Mississippian) and loess clay (Quaternary). The Cape Girardeau plant uses Joachim limestone (Ordovician) and Quaternary clay.

MONTANA.

Limestone is found chiefly in the western mountainous part of Montana, where it occurs in great abundance along the flanks of the mountain ranges. In the plains region, which comprises the eastern two-thirds of the State, the formations are mostly of Cretaceous age, except in the local uplifts of Little Rock, Judith, and Snowy mountains. The Cretaceous formations contain lenses and concretions of limestone which are available for burning to quicklime. In the mountainous regions the limestones are mainly of Paleozoic age, and the principal limestone-bearing series is the Mississippian, whose massive beds flank the great ranges of the State. Devonian and Silurian limestones are impure and the Cambrian limestones are thin bedded and generally irregular in composition. Limestone beds outcrop along the northern slope of the mountain front from Red Lodge, in Carbon County, westward to Livingston, northward about the flanks of the Bridger, Little Belt, and Belt ranges to the Main Range west of Great Falls. Practically all the southern ranges of the western part of the State are uplifts with cores of gneiss or granite mantled by limestones of various ages. Such rocks occur westward almost to the Bitterroot Valley. Deposits of interesting materials, probably suitable for cement manufacture, occur about 5 miles south of Havre. The materials consist of limestones of various grades, and shale. The limestones are notable because the action of igneous intrusions has produced in them considerable wollastonite, a natural lime silicate.

One Portland-cement plant, that of the Three Forks Portland Cement Co., has been recently established in Montana at Trident. Limestone, cement rock, and shale are used at this plant, and the clinker is burned with coal. The erection of at least one other plant in Montana is contemplated.

NEBRASKA.

The possible sources of cement material in Nebraska are contained in formations of Carboniferous and Cretaceous ages. Carboniferous limestone, shale, and sandstone underlie all of Nebraska. They outcrop in eastern Nebraska in Douglas, Sarpy, Cass, Lancaster, Otoe, Gage, Johnson, Pawnee, Nemaha, and Richardson counties. The exposures constitute cliffs along Platte River from Ashland to Plattsmouth, thence at intervals along Missouri River to the southeastern corner of the State, and occur in scattered outcrops along the valleys of Big Blue, Nemaha, and Little Nemaha rivers, and Weeping Water, Turkey, and Southeast Salt creeks and their branches. The Carboniferous rocks in this region comprise formations of Permian and Pennsylvanian ages. The Permian outcrops are probably restricted to the valley of Big Blue River from Beatrice southward. The rocks are, unfortunately, mainly magnesian limestones of light color, with interbedded shale.

Cretaceous rocks consisting of the Niobrara formation and the Benton group constitute a series of shales and chalky limestones. They have a thickness of about 450 feet to the east, but thicken to the west and south. At the base of the Benton group are about 200 feet of shale (Graneros shale) overlain by slabby limestones (Greenhorn limestone), followed by a series of shale beds (Carlile shale) with a few sandy layers, and overlying the Benton group is the Niobrara formation with an important thickness of chalky deposits interbedded with thin, hard, slabby limestone. The most extensive exposures of these rocks are along Missouri River from the north-central part of Cedar County to the north-central part of Boyd County, and along Republican Valley from Nuckolls County to Redwillow County. In the Republican Valley the Niobrara formation consists largely of limestone, but some of the beds contain much clay. The clay occurs mostly as an admixture in impure chalky limestone, but some beds contain so much clay that they are calcareous shale. The Niobrara strata are made up of alternating beds of soft, chalky limestone and calcareous clay from 5 to 30 feet thick. Chert occurs in the upper beds. The total thickness is perhaps 350 feet. Although the limestone varies considerably in its content of silica, alumina, and lime, the content of magnesia is uniformly low, generally less than 1 per cent.

No Portland cement has yet been manufactured in Nebraska, but development of the Cretaceous rocks at Superior, in the Republican Valley, is reported to be contemplated.

NEVADA.

Nevada contains numerous areas of low-magnesia limestone, mostly of Carboniferous age, though pure limestones of later date also occur within the State. The principal outcrops of the Carboniferous limestones are in the eastern part of the State. Much of this material is represented as suitable for manufacture into Portland cement.

No Portland cement has been made in Nevada, because at present the population is hardly great enough to afford a good local market for the material, and moreover, fuel supplies are also lacking and railroads are few and far between.

NEW HAMPSHIRE.

Many of the limestone and marble deposits of New Hampshire contain an excess of magnesia, but it is reported that limestones of satisfactory composition occur in several portions of the State. On account of the considerable development of the Portland cement industry in New York State, and of the lack of fuel and a good local market, no attempt has yet been made to establish a Portland cement industry in New Hampshire, and but little study has been made of the resources.

NEW JERSEY.

Limestones suitable for Portland cement manufacture occur in several geologic formations in New Jersey. Deposits of argillaceous Ordovician limestone of Lowville to Trenton age (Jacksonburg limestone) are, however, the principal sources of cement material, and in view of the great extent of these deposits it seems probable that the bulk of the New Jersey production will always be derived from these rocks. The distribution and character of the argillaceous limestone of Warren and Sussex counties has been studied in considerable detail. The other rocks possibly available are Silurian limestones occurring in the upper Delaware Valley, the white crystalline limestones probably of pre-Cambrian age that occur in the Highlands of New Jersey, and the shale marl deposits that occur in Sussex and Warren counties are also probably pure enough to be used for Portland cement manufacture.

New Jersey is an important Portland cement producer, the output of the State coming from three large plants belonging respectively to the Alpha Portland Cement Co., at Alpha, the Vulcanite Portland Cement Co., at Vulcanite, and the Edison Portland Cement Co., at New Village. These plants are all within what is known as the Lehigh district of Pennsylvania-New Jersey. They all use the Jacksonburg limestone ("Trenton cement rock") as their principal raw material, and they burn the cement with coal.

NEW MEXICO.

The detailed geologic work which has been done within the limits of New Mexico has been almost entirely with reference to metallic deposits and to coal areas, so that little is definitely known concerning the composition of the limestones of the State. It is known that limestones of the Ordovician, Silurian, Carboniferous, and Cretaceous systems occur in New Mexico, and it is probable that of these limestones those of the Pennsylvanian series ("Upper Carboniferous") will prove most suitable as sources of Portland cement material so far as extent, thickness, and composition are concerned. It is possible that the Cretaceous beds will also yield cement materials at many points in their area of outcrop.

In the vicinity of Carthage,[1] Socorro County, there is an area of limestone and shale so situated with regard to fuel and market as to warrant practical tests of the raw materials and a thorough study of the various conditions that relate to the cement industry in this section of the Southwest. The San Andreas limestone of the Manzano group of the Pennsylvanian series, having a thickness of about 200 feet, outcrops in the southwest quarter of T. 5 S., R. 2 E. of the New Mexico principal meridian. In the immediate locality of the limestone there are thick exposures of Cretaceous clay shale. Both the limestone and the shale show every physical appearance of being suitable for combination in the making of cement. This area is within half a mile of the New Mexico Midland Railroad, which draws high-grade coal from Carthage, less than 2 miles distant. The New Mexico Midland connects at San Antonio, N. Mex., with the Santa Fe Railway.

No Portland cement has yet been manufactured in New Mexico, but many years ago a small plant manufactured natural cement at Springer, utilizing materials derived from Cretaceous rocks.

NEW YORK.

An extensive series of limestones outcrop within New York State, and of these six are sufficiently satisfactory in thickness, areal extent, chemical composition, and market advantages to be worth considering as possible sources of Portland cement manufacture. These six limestones, named in their geologic order, from the earliest to the latest, are (1) the Chazy limestone, of Ordovician age; (2) Mohawkian limestones, of Ordovician age; (3) Clinton formation, of Silurian age; (4) Helderberg group and Onondaga limestone, of Devonian age; (5) Tully limestone, of Devonian age; and (6) marls, of Quaternary age. All of these materials except those of Chazy and Clinton ages are at present utilized in Portland cement manufacture in New York.

The Chazy limestone is confined practically to the Lake Champlain valley. It outcrops on the west shore of Lake Champlain a few miles south of Crown Point village, and also outcrops in Crown Point itself. It appears again on the lake shore about 5 miles south of Westport near Essex Village, and on Willsboro Point. Its most characteristic and extensive outcrops are in the eastern part

[1] Personal communication from J. H. Gardner, geologist, Lexington, Ky.

of Clinton County. It is well exposed on Valcour Island and on Isle la Motte, where it has been extensively quarried. It also occupies large areas north of Valcour and west of Plattsburg, where it is quarried. The largest single area is in the northeastern part of Clinton County, where it has been worked extensively for lime and building stone. This area extends from the village of West Chazy to the lake shore, and northward to the Canadian line near Rouse Point. The Chazy is usually a very pure limestone, low in magnesia and clayey matter. It is commonly bluish to grayish in color, and has a slightly crystalline appearance. Rarely it carries high percentages of silica and alumina. The relatively high cost of fuel in the Champlain valley and the distance from large local cement markets will perhaps prevent any great development of a cement industry based on the Chazy limestone, though the stone itself is well adapted to cement manufacture and good clay and shale are readily obtainable in the same district.

The Mohawkian limestones, which include the Trenton limestone, are widely distributed throughout New York State. They appear in the valleys of Lake Champlain, Hudson River, Mohawk River, and Black River, and are the most important quarry stones of most of the districts in which they occur. In northern New York and in southeastern New York they are very different in character. In northern New York Mohawkian limestone forms a more or less continuous belt encircling the Adirondacks on the east, southeast, and southwest sides. It is quarried on Isle la Motte, at Plattsburg, on Larabees Point, and at Crown Point. Near Glens Falls the belt enters the State from Vermont and extends south toward Saratoga. The most extensive area of Mohawkian limestone in the State lies mostly in Oneida, Lewis, and Jefferson counties, along the valleys of West Canada Creek and Black River. It commences as a narrow belt, but widens to about 20 miles at Waterloo and extends along the St. Lawrence-Lake Ontario shore from near Clayton to Port Ontario, a distance of over 50 miles. It is quarried at many points in Jefferson County. The Mohawkian limestone in northern New York is in general a pure, nonmagnesian rock, dark gray to almost black in color, and commonly fossiliferous. In southeastern New York a number of isolated areas of Mohawkian limestone occur in the Hudson River valley, from Albany southward to the Highlands. This area is a comparatively recent discovery, and owing to the favorable location of many of the outcrops they have a proportionately high value. On the east side of the Hudson conditions are most favorable, and a belt of limestone outcrops near Poughkeepsie have been tested and found to range from fairly pure limestone carrying 95 to 96 per cent calcium carbonate down to cement rock of a grade about like that occurring in the Bath and Nazareth portions of the Lehigh district. This New York cement rock will not require the addition of pure limestone as would the cement rock of the Pennsylvania-New Jersey Lehigh region, but it will usually require the addition of some clay or shale, and fortunately the Ordovician shale and Quaternary clay are conveniently located and abundant in quantity. The magnesia is generally near the maximum limit, and in this respect these rocks are similar to the cement rock of the Lehigh district.

Limestones of Clinton age occur in the western part of New York, and though not particularly thick or of high grade they are of great value because of the lack of better stone in a region where the demand is great. This rock extends eastward from Niagara River north of Buffalo well into the lake region of New York. In the eastern portion of its outcrops the Clinton is argillaceous, the limestone beds being few and so thin as to be negligible, as for instance, at the type locality, Clinton, Oneida County. Westward from Rochester the beds of Clinton age become thinner and increasingly calcareous, so that where they cross Niagara River into Canada they are essentially limestone with unimportant bands of interbedded shale. The general section in the Lockport-Lewiston district shows the limestones of Clinton age to consist of an upper, white limestone with a maximum thickness of 14 feet, a middle gray limestone 8 feet thick, and a lower, dark limestone 8 feet thick, underlain by green shale. At the quarries of the Lackawanna Steel Co., near Pekin, the upper limestone ranges from 8 to 12 feet in thickness, its maximum thickness not being represented, owing to erosion. Chemically the three limestones are distinct in composition. The upper one is fairly low in silica, alumina, and iron oxide, and carries generally from 90 to 95 per cent calcium carbonate, and 3 to 5 per cent magnesium carbonate. The middle member carries from 20 to 30 per cent magnesium carbonate, and is also high in insoluble matter. The bottom limestone, though higher in silica, alumina, and iron oxide than the top one, carries a lower percentage of magnesium carbonate.

The Helderberg group and Onondaga limestone are the most important limestones with reference to present or possible sources of Portland-cement material. The two are separated by a comparatively thin bed of sandstone, the Oriskany, also in some areas by the Schoharie and Esopus grits. The Helderberg group is divisible into several well-marked formations. These limestones, either in whole or in part, extend eastward from Buffalo, where only the Onondaga limestone is present, to Oriskany Falls, Oneida County. Here the belt turns southeastward nearly to South Bethlehem, Albany County. From this point the outcrops of the limestones trend almost parallel to and a little west of Hudson River, nearly to Kingston. The belt then turns southwestward, passing through Ellenville and Port Jervis into Pennsylvania and New Jersey. The character of these limestones varies considerably from place to place. From Seneca County westward the Onondaga limestone carries normally a very large percentage of chert, but in Erie County a number of rather large lenses of nonsiliceous limestone have been found near the base and in times past have furnished the bulk of the stone used in the Buffalo district for flux, chemical use, and building lime. The tonnage available from these lenses is apparently limited, and the supply from this source can not last many years. In central New York, or between Albany and Seneca counties, these limestones offer greater possibilities for securing the supply of nonmagnesian and nonsiliceous rock. The Onondaga limestone is not appreciably better, so far as silica is concerned, than in western New York, but members of the Helderberg group are present below it, and these furnish, in places, an excellent stone for cement-making purposes. In the Hudson Valley the Helderberg attains its maximum importance, not only because of the character of its limestone, but because of the large market to which its location makes it tributary. In this area the Helderberg forms a very thick group, which has been divided into a number of formations. In Ulster County the following rocks are exposed, beginning with the lowest: The Manlius limestone, at the top of the Silurian, is 20 to 40 feet thick; the Coeymans limestone, at the bottom of the Helderberg, is 30 to 60 feet thick; the New Scotland limestone is 60 feet thick; the Becraft limestone is 20 to 30 feet thick; the Port Ewen limestone is 30 to 125 feet thick and constitutes the remaining formation in the Helderberg group. Above the Port Ewen lies the Oriskany sandstone, 5 to 30 feet thick, followed by the Esopus and Schoharie grits, 200 to 300 feet thick, over which lies the Onondaga limestone, 60 feet thick. These same formations are exposed in Becraft Mountain, Columbia County, with thicknesses varying somewhat from those just given. Analyses of the Becraft limestone show it to run between 1.8 and 7.1 per cent of silica. Alumina and iron oxide run between 0.5 and 4 per cent, the lime or calcium oxide between 45 and 54 per cent, and the magnesia generally less than 1 per cent, although occasionally a sample is found to carry as high as 2.25 per cent. The Manlius limestone has almost the same composition, with the exception that the silica is a trifle higher.

The Tully limestone (Devonian) occurs only in central New York and occupies a greater area than any other limestone in that part of the State. Its line of outcrops crosses all of the Finger Lakes, on the shores of most of which the limestone is well exposed, and the belt is crossed by numerous railroad lines leading to the coal regions of Pennsylvania. This limestone is comparatively thin, but its advantageous distribution and its high quality make it a valuable Portland cement material. It is low in magnesia, rarely carrying over 1.5 per cent of magnesium carbonate. It commonly carries a rather large percentage of silica, alumina, and iron oxide, in places approximating in composition the cement rock of the Lehigh district. This limestone is immediately underlain by shale, which has been found to be well adapted to mixing with the limestone.

The Quaternary marl occurs in the form of small deposits at many points in eastern and northern New York, lying in old lake basins and forming swampy tracts overlain by impure peat. So far as known, none of the deposits of this part of the State are of workable size, but in western and central New York large marl deposits have been found at many points, such as at Montezuma, Cayuga County; Jordan and Warners, Onondaga County; Caledonia, Genessee County; Wayland and Perkinsville, Steuben County; Cassadaga Lake, Chautauqua County; near Canastota, Oneida County; at Cortland, Cortland County; Clifton Springs, Ontario County; Clarendon, Orleans County; and Bergen, Genessee County. The marls of New York are generally low in silica, alumina, and iron oxide, high in lime, and low in magnesia. In places as high as 6 or 7 per cent of silica may be found.

In 1910 eight Portland cement plants were in operation in New York State. The Alsen's American Portland Cement Works, at Alsen, uses Becraft limestone and clay of Quaternary age. Excellent shale is reported to occur in the vicinity of the plant, which may be used if necessary. At the plant of the Catskill Cement Co., at Cementon, Greene County, the materials used are limestone of Helderberg age and Quaternary clay from the river terraces. The Glens Falls

Portland Cement Co., at Glens Falls, uses a cement rock of Trenton age, and clay which overlies the rock. The plant of the Helderberg Cement Co., at Howes Cave, Schoharie County, utilizes the Becraft and Manlius limestones mixed with clay of Quaternary age. The plant of the Cayuga Lake Cement Co., at Portland Point, Tompkins County, on the east shore of Cayuga Lake, uses the Tully limestone and shale from the underlying Hamilton formation. The plant of the New York and New England Lime and Cement Co., at Hudson, began operations in 1910, utilizing Devonian limestone. The Wayland Portland Cement Co., at Wayland, Steuben County, utilizes marl and clay. The marl deposit is near the mill, but the clay is brought from a bank at Mount Morris, Livingston County. The Marengo Portland Cement Co., at Caledonia, utilizes a local marl deposit and clay reported to be shipped from Genesee County. In addition to the plants above described, several plants which were producers until recently were idle in 1910. Two plants were reported in 1910 to be under construction, namely, that of the Seaboard Portland Cement Co., on the west bank of Hudson River, near Alsen, and that of the Knickerbocker Portland Cement Co., on the east side of the river, near Hudson. The latter plant was reported to be producing cement in the summer of 1911. Both of these plants were designed to use the Becraft limestone in connection with clay or shale in their cement mixture. Coal is reported to be used as fuel in all the plants in New York, except that of the Wayland Portland Cement Co., which uses coke for burning its cement.

NORTH CAROLINA.

The limestones possibly suitable for cement manufacture in North Carolina fall into two classes, distinct geographically as well as geologically. They are (1) the crystalline limestones of western North Carolina and (2) the soft limestones of eastern North Carolina. In the extensive area of metamorphic and igneous rocks that covers the western half of North Carolina outcrops of crystalline limestones or marbles are common. Many of these marbles are highly magnesian, but certain of them are low in magnesia. Commercial considerations render them at present of little value for Portland cement manufacture. In eastern North Carolina heavy beds of soft limestone or "shell beds" occur in the Tertiary rocks of the Coastal Plain. These shell beds are termed "marls" in early geologic reports, but should not be confused with the fresh water marls so largely used as cement materials in Michigan and Indiana. These beds are usually low in magnesia, but in places contain considerable percentages of clayey matter or of sand. They occur as thin, but fairly continuous beds made up of shell or fragmental material, and extend along the entire coast of North Carolina, being best exposed along the larger streams. As these beds were originally simply masses of shell, loosely compacted and porous, deposits of sands and sandy clays that were spread over them have naturally sifted down into and through the shell deposits, so that the beds as they exist now are nearly everywhere full of sand grains. Tests that have been recently made of these materials show them generally to be too siliceous to be suitable for use in either the Portland cement or the lime industry. The local clays are also rather sandy, and fuel in this area is by no means cheap.

Therefore the problem of utilizing these marls commercially is difficult. No Portland cement plants have ever been operated in North Carolina, owing to the conditions just outlined.

NORTH DAKOTA.

The Niobrara limestone, of Upper Cretaceous age, is the only limestone formation of importance to the cement industry in North Dakota. In most places this formation is covered by a thick deposit of glacial drift. The physical characters and chemical composition of the Niobrara limestone render it of peculiar value as a cement material, both because of its softness, which permits it to be easily crushed and pulverized, and because of its general freedom from magnesia and other injurious ingredients. In northeastern North Dakota the distribution of this rock has been studied by the State Geological Survey. In the Pembina Mountain region this rock is a rather siliceous, soft, limestone and shale formation about 150 to 165 feet thick. The results of the work of the State Survey seem to indicate that the rock is more suited to the manufacture of a natural hydraulic cement than to a Portland cement. The Northern Cement & Plaster Co. has operated a plant at Concrete, the products of which included bricklayer's cement, hydraulic cement, cement plaster, and stucco. No production was reported from here in 1910.

OHIO.

Seven geologic divisions in Ohio contain low magnesia limestones. Beginning with the lowest these are the "Trenton" limestone and the limestones of the Cincinnatian series, both of Ordovician age; the "Clinton" limestone, of Silurian age; the "Corniferous" limestone, of Devonian age; the Maxville limestone, of Mississippian age; certain Pennsylvanian or "Coal Measures" limestones; and Quaternary marls. The "Trenton" consists of pure limestone and shale. It outcrops as a narrow strip along Ohio River from the mouth of the Little Miami to a mile or two above New Richmond. The Cincinnatian rocks may be separated into three well-marked divisions: The lowest, about 250 feet thick, consists almost entirely of shale; the middle division, 200 to 250 feet thick, contains numerous layers of limestone 3 to 20 feet thick; and the upper division (Richmond) consists of numerous alternating beds of soft shale and limestone, with generally a heavy bed of shale at the base and top. The limestones of Ordovician age just mentioned do not in all places carry sufficient lime for use in the Portland cement industry. Even where they are of favorable composition the silica is fairly high, so that the material approaches the composition of natural cement rock. The "Clinton" limestone, exposed and quarried at many points in southwestern Ohio, is commonly fairly low in magnesia, and ranges from 80 to 95 per cent lime carbonate. Some beds may carry as high as 10 per cent magnesium carbonate. Suitable limestone of this age occurs in Montgomery, Adams, Miami, Clark, and Greene counties. The "Corniferous" limestone, which corresponds approximately to the Onondaga limestone of New York, contains heavy beds of magnesian limestone, with a smaller quantity of limestone low in magnesia. The beds vary so greatly within a single quarry that the rock is of somewhat doubtful value as a cement material. This rock outcrops as a narrow strip extending north and south from Lake Erie to below Columbus, and crosses portions of Erie, Sandusky, Huron, Seneca, Crawford, Wyandot, Marion, Delaware, and Franklin counties. The well-known quarries on Kelleys Island in Lake Erie are in this formation. The Maxville limestone is usually low in magnesia and fairly high in lime, ranging from 80 to 90 per cent lime carbonate. This limestone encircles the coal fields of Ohio. Limestone beds occur at intervals within the Pennsylvanian series in eastern Ohio. Most of these beds are of only local importance. One bed, known as the Vanport ("Ferriferous") limestone member of the Allegheny formation, is of considerable importance to the Portland cement industry. It varies in thickness from 8 to 16 feet or more, and is everywhere low in magnesia. Deposits of Quaternary marl occur at various points in Ohio, but not so extensively as in Indiana and Michigan.

Five plants produced Portland cement in Ohio in 1910. The plants using limestone with clay or shale were the Ironton Portland Cement Co., at Ironton, the Diamond Portland Cement Co., at Middlebranch, and the Superior Portland Cement Co., at Superior; those using marl and clay were the Sandusky Portland Cement Co., at Baybridge, and the Castalia Portland Cement Co., at Castalia. The York Portland Cement Co., at New Boston, which utilizes limestone, was reported to be rebuilding its plant, and the plant of the Lehigh Portland Cement Co., at Wellston, was not in operation during the year. Coal is reported to be the fuel at the plants at Baybridge, Castalia, Middlebranch, and Superior; natural gas is reported from Ironton.

OKLAHOMA.

Limestones of several different ages occur in Oklahoma, and it is probable that most of them would be suitable, in places, for cement materials. The earliest rocks are those of Cambrian, Ordovician, and Silurian ages, which have a total thickness of nearly 8,000 feet, and make up a large part of the Arbuckle Mountains and the northern foothills of the Wichita Mountains. The lowest of these, the Arbuckle limestone, consists of limestone and dolomite of Cambrian and Ordovician age. It is 4,000 to 6,000 feet thick, and samples from the lower part and from the upper 600 or 700 feet have been tested for magnesia and lime, and showed a very small percentage of magnesia. Probably 2,000 feet of massive beds in the middle part of the formation are highly magnesian. The Viola limestone, of Ordovician age, 500 to 700 feet thick, outcrops in a belt about the border of the Arbuckle Mountains and in small areas in the central part. It also occurs in three small hillls near Rainy Mountain Mission, in the Wichita Mountains. This formation contains local deposits of chert, but samples taken from the Arbuckle Mountain area show it to contain very little magnesia. It is fine textured and generally hard. Above the Viola limestone is a greenish clay shale, 50 to 300 feet thick, of Silurian age, known as the Sylvan shale. This shale outcrops in narrow belts, and has a wide distribution in the Arbuckle Mountains. Possibly it may be of value for mixing with the Viola limestone. Above the Sylvan shale lies the series of Silurian and Devonian limestones which have been called "Hunton limestone." They have an average thickness of about 200 feet, and vary in physical character and composition. A massive bed at the base is in places almost pure white limestone; in other places it is in large part siliceous. Toward the middle, beds of clay and "marl" are interstratified with the limestone. Near the middle the beds contain a small amount of magnesia, and toward the top local segregations of chert are found. Like the Viola limestone these limestones outcrop around the borders of the Arbuckle Mountains in a narrow belt, besides occurring in many small areas in the central part of the uplift. In northern Oklahoma are a few belts of Carboniferous limestone, continuations of the areas which are so important in Kansas. These limestones thin out and disappear to the south, and are of workable thickness only in the northern part of the State. Other limestones of Carboniferous age occur in eastern Oklahoma and extend into Arkansas north of the Boston Mountains. These limestones are thin bedded, and with them are associated deposits of blue to black clayey shale. Very little magnesia is contained in these deposits. Along the southern edge of the coal field outcrops a long lentil of Carboniferous limestone, which attains in places a thickness of nearly 300 feet. The eastern end of this belt extends nearly to the Arkansas line on the north flank of the Ouachita Mountains, and the western end reaches the Arbuckle Mountains. Cretaceous limestones occur in the southern part of the State, and several distinct formations are associated with limy clays. These limestones are mostly soft, thin bedded, and of various shades from light blue to white. The lowest bed is masive, white, and generally homogeneous. The Cretaceous formations continue southward in unbroken exposures from Red River and, judged by analyses of very similar beds occurring in Texas, are probably low in magnesia.

Two Portland cement plants are now in operation in Oklahoma, the plant of the Dewey Portland Cement Co., at Dewey, and that of the Oklahoma Portland Cement Co., near Ada. At the Dewey plant limestone of Pennsylvanian age is quarried 1½ miles east of the plant, mixed with Pennsylvanian shale and a small amount of Quaternary clay. Natural gas is used as fuel, both for power purposes and for burning the clinker. The Oklahoma Portland Cement Co. obtains the shale and limestone used in its plant from a quarry 6 miles distant. The limestone and shale are of Carboniferous age, and coal is used as fuel, but it is reported that its use is to be supplanted by oil in the near future. A third plant is reported as being constructed at Hartshorne, Okla., by the Choctaw Portland Cement Co. The rock to be utilized is the Wapanucka limestone, of Carboniferous age, with shale which occurs beneath the limestone. Coal will be used as fuel.

OREGON.

Limestones occur in southwestern and in northeastern Oregon. The limestone occurring in southwestern Oregon is well developed at a number of points in Jackson and Josephine Counties, and has been used to a considerable extent for lime burning and flux. These limestones are probably of Devonian, Carboniferous, and Cretaceous age. They occur as lenses of greater or less extent in the partly altered rocks of the district. Several of these lenticular beds of limestone outcrop in the neighborhood of Rockpoint, on Rogue River, Jackson County, and have been exploited for various purposes. The belt of limestone lenses extends southwest from Rockpoint, with several prominent outcrops on the tributaries of Applegate, especially on Steamboat and on Williams Creeks, where the massive limestone forms celebrated caverns. Similar beds occur on Sucker Creek, southeast of Waldo near the California line. Their distribution is extremely irregular, owing to the predominance of igneous rocks. Large deposits are reported to occur near the California line on Williams Creek, in the southeast corner of Josephine County. In northeast Oregon the largest and most accessible limestone deposit that has been reported is at Lime, on Burnt River, about 3 miles above Huntington, Baker County. The limestone beds at this point are associated with shale, and the entire series is upturned steeply. A thickness of about 100 feet of limestone is exposed by the river. The stone is reported to be very pure, carrying generally less than 1 per cent of silica, alumina, and iron oxide. The same series of beds outcrop on the hills southwest and northeast, and continue across Snake River into Idaho. The material is now being utilized for lime burning. Limestone deposits are reported to occur in other parts of Baker County, and in Grant and Union counties. In Wallowa County deposits of marble are reported to occur, and considerable lime is burned at Lostine.

No Portland cement is now manufactured in Oregon, although, according to the early volumes of Mineral Resources, a small quantity of Portland cement was made about 1886–1887 at Oregon City, Clackamas County. The material used was a natural cement rock found in Douglas County. It was also reported that this was the first attempt in the United States to employ the Ransome process, or rotary kiln, for making Portland cement. Producer gas was used as fuel.

PENNSYLVANIA.

A number of limestones suitable for use as Portland cement materials occur in Pennsylvania. One of them—the Ordovician—is of particular importance on account of its character and location. The important limestones, beginning with the lowest, are: (1) The Ordovician; (2) the Devonian and Silurian, which include the Lewistown limestone (Helderberg and Cayuga); and (3) certain Carboniferous limestones. The Ordovician limestones, which furnish the well-known cement rock of the Lehigh district, occur in varying development in the counties of Northampton, Lehigh, Berks, Lebanon, Dauphin, Cumberland, Franklin, Lancaster, Center, and Blair, and to a much less extent in several other counties of southeastern Pennsylvania. They belong to the Shenandoah group, and throughout eastern Pennsylvania they are underlain by a highly magnesian rock and overlain by a thick series of shale and slate. These limestones are in many places within the allowable limit of magnesia, and are, therefore, in such places an excellent Portland cement material. In places their value is increased by the presence of a high percentage of clayey matter which renders the material a natural cement rock. The Lewistown limestone outcrops in central Pennsylvania and the Helderberg limestone in eastern Pennsylvania in a series of narrow bands whose distribution is rather complicated, owing to the geologic structure and the topography of the region. Among the Carboniferous limestones may be mentioned the following, beginning at the lowest: Loyalhanna limestone (member of Pocono formation), 60 feet thick; Greenbrier limestone (member of Mauch Chunk formation), 30 feet; Upper Mercer and Lower Mercer limestones (members of Pottsville formation), 7 feet; Vanport limestone (member of Allegheny formation), 20 feet; Johnstown limestone (member of Allegheny formation), 10 feet; Lower and Upper Freeport limestones (members of Allegheny formation), 5 and 28 feet, respectively; Ames limestone (member of Conemaugh formation), 8 feet; Elk Lick limestone (member of Conemaugh formation), 6 feet; Pittsburg limestone (member of Conemaugh formation), 12 feet; Redstone limestone (member of Monongahela formation), 10 feet; Fishpot limestone (member of Monongahela formation), 30 feet; Benwood limestone and Uniontown limestone (members of Monongahela formation), 73 feet; Waynesburg limestone (member of Monongahela formation), 35 feet; and the Upper Washington limestone (member of Washington formation), 30 feet. The Greenbrier and Loyalhanna limestones are of Mississippian age, and the Upper Washington limestone is of Permian age. All the others belong to the Pennsylvanian series. Many analyses of the Vanport limestone show it to be low in magnesia, comparatively high in lime carbonate, and to contain moderate percentages of silica and alumina.

Twenty-five plants produced Portland cement in 1910. Of these, 20 plants were located in the Lehigh district as follows: Blanc Stainless Cement Co., Allentown; Bath Portland Cement Co., Bath; Pennsylvania Cement Co., Bath; Atlas Portland Cement Co., Northampton and Coplay; Coplay Cement Manufacturing Co., Coplay; Central Cement Co., Egypt; Reliance Cement Co., Lesley; American Cement Co. of Pennsylvania, Egypt; Alpha Portland Cement Co., Martins Creek; Dexter Portland Cement Co., Nazareth; Nazareth Cement Co., Nazareth; Phoenix Portland Cement Co., Nazareth; Lehigh Portland Cement Co., Ormrod, West Coplay, and Fogelsville; Penn-Allen Cement Co., Penn-Allen, near Nazareth; Lawrence Portland Cement Co., Siegfried; Allentown Portland Cement Co., Evansville; and Northampton Portland Cement Co., Stockertown. All these plants use limestone and cement rock or cement rock alone, except the Blanc Stainless Cement Co., which uses limestone and clay and produces a white Portland cement. Aside from these plants there are five plants not in the Lehigh district, as follows: The Universal Portland Cement Co., at Universal, near Pittsburg, which uses blast furnace slag and limestone; the New Castle Portland Cement Co., and the Lehigh Portland Cement Co. (formerly the Shenango Co.), at Newcastle, utilizing limestone and shale; the Crescent Portland Cement Co., at Wampum, also using limestone and shale; and the Sandusky Portland Cement Co., at York, which manufactures a white Portland cement from limestone and clay. Nearly all these plants use coal for fuel. In two cases oil is reported as used for fuel, and in one case both oil and coal are the fuel.

RHODE ISLAND.

Few limestone deposits large enough to be considered of economic importance occur in the State of Rhode Island. At Limerock, Providence County, quarries have been worked, the product being used largely or entirely for lime burning. This rock carries too high a percentage of magnesium carbonate to permit its use as a Portland cement material. No Portland cement industry has been established in Rhode Island.

SOUTH CAROLINA.

In South Carolina, as in North Carolina, the limestones possibly available for Portland cement making may be divided into two divisions, geologically and geographically. The western portion of the State contains a number of beds of matamorphosed limestone or marble that are probably satisfactory in composition, but fuel supply, large local markets for Portland cement, and cheap transportation are all lacking. At Gaffney limestone is burned to lime. In the Coastal Plain soft limestone or shell beds of Tertiary age, the so-called "marls," outcrop at many points. No Portland cement plant has been established in South Carolina.

SOUTH DAKOTA.

The limestone formations of South Dakota which may be considered in connection with Portland cement manufacture occur in two different portions of the State. The rocks may thus be separated geographically, as well as geologically, into the following groups: (1) Limestones of the Black Hills district, and (2) the chalk of eastern South Dakota. Beginning at the lowest, the principal limestone formations occurring around the border of the Black Hills uplift are the Whitewood limestone, of Ordovician age, which reaches a thickness of 80 feet in places; the Pahasapa limestone, of Mississippian age, ranging from 250 to 500 feet thick; the Minnekahta limestone, of Permian age, 30 to 50 feet thick; the Minnewaste limestone, of Lower Cretaceous age, reaching 30 feet in thickness in places; the Greenhorn limestone, 50 feet thick; and the Niobrara formation, containing chalk and calcareous shale, 225 feet thick. The latter two are of Upper Cretaceous age. In the extreme southeastern part of the State the Niobrara chalk furnishes an excellent raw material for Portland cement manufacture. The character of these rocks has been discussed in the section on Iowa. The Niobrara chalk is well exposed in numerous bluffs along Missouri River, from Yankton to Chamberlain, and it also outcrops in smaller isolated areas elsewhere in the southeastern part of the State.

In 1910 there were no Portland cement plants operating in South Dakota. The plant of the Western Portland Cement Co., which was operated for many years at Yankton and which utilized the Niobrara limestone and the overlying Cretaceous shale as raw materials, was idle during 1910. For some time there has been a movement on foot to establish a plant at Chamberlain.

TENNESSEE.

Limestone and shale occur abundantly in east and middle Tennessee, and much of this material probably has the chemical composition and physical properties required in the manufacture of Portland cement. In east Tennessee the most promising materials are confined to the Appalachian Valley, in which numerous large and easily quarried outcrops of nonmagnesian limestone and shale alternate with bands of magnesian limestone, shale, and sandstone. The age of the suitable limestone is Ordovician. One of the great valley-making limestones, known as the Knox dolomite, is rarely ever found to contain a percentage of magnesia low enough to permit the rock to be used for Portland cement making. The beds of limestone in which the magnesian content is low lie mostly above the Knox dolomite. Ordovician formations of the eastern part of the Great Valley in east Tennessee are as follows, beginning with the lowest: Chickamauga limestone, Holston marble, Moccasin limestone, Tellico sandstone, and Sevier shale. In places extensive beds of limestone occur locally in the Sevier shale. Such beds are well developed between Knoxville and Athens. Thinner and more earthy beds of limestone occur also, but less commonly, in the Athens shale. In the western half of the valley the Ordovician limestones are all included in a single formation, the Chickamauga limestone. This limestone ranges from 1,200 to 2,000 feet in thickness. Locally, especially toward the top, the limestone includes many thin beds of shale, and some other layers contain considerable clayey matter, while a few are siliceous and on decomposition give rise to chert. The percentage of magnesia, however, is almost everywhere low. Highly argillaceous limestone beds occur in the lower half of this formation near Chattanooga. In western and middle Tennessee the Ordovician limestones form a large basin of nearly horizontal rocks. The Stones River group includes a number of nonmagnesian limestones, as follows: The Murfreesboro limestone, outcropping near the town of that name, has a thickness of about 70 feet and covers an area 12 to 14 miles in diameter. The Pierce limestone, having a maximum thickness of less than 30 feet, rests on the Murfreesboro limestone and forms a narrow belt around the outcrops of that formation. The Ridley limestone, having a thickness of 80 to 100 feet, outcrops in an irregular, circular band around the Murfreesboro area, and in small areas in Bedford and Marshall counties. This formation carries a little chert. The Lebanon limestone has lithologic characters similar to those of the Pierce limestone. It has a thickness of 100 feet or more, and occupies a larger area than the preceding limestones. It outcrops in the vicinity of Lebanon, Lewisburg, Shelbyville, La Vergne, and Fosterville, also in the bluffs of Duck River at Columbia. The formation carries considerable argillaceous limestone. The Carter limestone, the uppermost division of the Stones River group, is 40 to 80 feet thick. It occurs in all of the counties in the central basin, and is used in many places for making lime. Limestones of Trenton age form a wide but irregular belt completely encircling the central areas of the Stones River group. The Trenton rocks consist almost entirely of limestone, but vary considerably from place to place in their lithologic characters. Where these rocks occur in the counties bordering Cumberland River, they are particularly promising as cement materials.

Silurian and Devonian limestones outcrop also in east and middle Tennessee. They include the Hancock limestone, of Devonian and Silurian age, of northeastern Tennessee, the Clifton formation of western Tennessee, which is of Niagara age, and the Linden formation, of middle and western Tennessee, which is of Helderberg age. The Clifton and Linden formations outcrop chiefly along Tennessee River, and contain interstratified beds of shale.

Mississippian formations also carry nonmagnesian limestones in Tennessee. Of these the Fort Payne is the lowest, but it is prevailingly siliceous and cherty. The overlying St. Louis limestone covers the greater parts of Robertson, Montgomery, and Stewart counties, and adjoins counties in southwestern Kentucky in which the same formation prevails. The St. Louis is 200 to 300 feet thick and consists mainly of gray and blue, thick-bedded, cherty limestone. Near its base, especially in Montgomery County, the formation commonly includes many beds of high-grade limestone, which in some areas are underlain by oolitic and semioolitic limestone regarded as of the same geologic age as the Spergen limestone of Indiana. In eastern Tennessee the Mississippian rocks above the Fort Payne chert are divided into (1) the Pennington shale, at the top, and (2) a limestone formation below, which to the north is called Newman limestone, having been traced from the Newman area of southwestern Virginia, and to the south is called Bangor limestone, being there continuous with the Bangor limestone of Alabama. The limestones in the Pennington shale are generally thin and of small local extent.

In 1910 one Portland cement plant was in operation in Tennessee, that of the Dixie Portland Cement Co., at Richard City, near South Pittsburg. This plant uses limestone from the Bangor limestone, and shale, also of Mississippian age, and coal as fuel. The plant of the Clinchfield Portland Cement Co., at Kingsport, Tenn., was reported as completed in 1911.

TEXAS.

There are a number of limestone formations in Texas which yield material suitable for making Portland cement. Carboniferous rocks are reported to occur in north-central Texas, and in the Trans-Pecos region of western Texas, but the limestones of Cretaceous age in central, northern, and extreme western Texas are probably the best adapted for making Portland cement. The principal area of Cretaceous rocks in Texas occurs as a wide belt extending southward across the central part of the State from Red River to the Rio Grande. The cities of Sherman, Dallas, Fort Worth, Waco, Austin, and San Antonio are located on this belt. A railroad either follows or parallels this belt of Cretaceous rocks, and many railroads cross it. Two divisions of the Cretaceous system contain limestone deposits of remarkable purity. These are the Austin chalk and the limestones of the Fredericksburg group (Goodland limestone to the north and Edwards limestone and Comanche Peak limestone to the south). The Austin chalk is a massive, white, friable, chalky limestone. It is several hundred feet thick, and carries from 70 to 90 per cent of carbonate of lime, and generally less than three-fourths of 1 per cent of magnesium carbonate. The silica is variable, and in places increases in quantity as the lime carbonate decreases, so that the rock becomes almost a cement rock, as, for instance, near Austin. The limestones of the Fredericksburg group are situated west of and generally parallel to the outcrop of the Austin chalk. They occur in large areas in Wise, Parker, Hood, Erath, Bosque, Hamilton, Coryell, Lampasas, Burnet, Blanco, Kendall, Comal, and Bexar counties. Large areas are exposed in the Edwards Plateau west of San Antonio. North of the Brazos River valley they are represented by the Goodland limestone, a massive, semicrystalline, white limestone 30 to 50 feet thick. From the Brazos River valley southward they gradually increase in thickness, reaching 300 feet on Colorado River.

In central Texas the lower part is a massive, white chalky limestone nearly 100 feet thick (Comanche Peak limestone), and the upper part is composed of thick beds of nearly pure chalky and siliceous limestone beds alternately stratified (Edwards limestone). These siliceous beds contain quantities of nodular and almost pure flints.

Four plants produced Portland cement in Texas in 1910. These plants are as follows: The Texas Portland Cement Co., at Cement, and the Southwestern States Portland Cement Co., at Eagle Ford, both being near Dallas and utilizing limestone from the Austin chalk and shale from the Eagle Ford clay. The Alamo Cement Co., at San Antonio, uses cement rock from the Austin chalk, and the Southwestern Portland Cement Co., at El Paso, uses limestone and cement rock of Cretaceous age. Oil is used as fuel at the plants near Dallas, coal and oil at San Antonio, and coal at El Paso.

UTAH.

Limestones generally low in magnesium carbonate occur at many points in the Wasatch Mountain area in Utah. Most of these rocks are of Carboniferous age. Many of them contain so much clayey matter as to fall below 75 per cent in lime carbonate, in which case they approach in composition the cement rock of the Lehigh district of Pennsylvania. In the Plateau district softer limestone of Tertiary age occur. In addition to the limestones just mentioned an interesting material has newly been discovered to be of value in the manufacture of Portland cement. It occurs in the form of marl underlain by clay. This deposit lies in the abandoned bed of a portion of the old Salt Lake Basin. It is a homogeneous, unstratified, grayish, fine-grained soft marl. At the surface the material is, in midsummer, fairly dry to the depth of 1 foot or more, but becomes damp below, and at the base salty water seeps in and fills holes where the underlying clay is excavated. The clay underlying the loam ranges from light gray through yellow to bluish in color, and is also fine grained. The deposit referred to lies 5.6 miles northwest of Brigham. The nearest remnant of Salt Lake is a small lake known as Boxelder Lake, a marshy tract which lies a short distance south of the marl deposit. The marl is 4 to 10 feet deep, and the clay has been tested to a depth of 18 feet. The marl runs generally between 1 and 3 per cent of magnesium oxide, between 40 and 46 per cent of calcium oxide, between 7 and 12 per cent silica, and between 1 and 3.5 per cent of alumina plus iron oxide. There has been found as high as 4.5 per cent sodium chloride (salt) in the marl, and the wet material carries as high as 32.29 per cent moisture. The clay carries 48 to 50 per cent silica, 16.5 to 18.6 per cent alumina plus iron oxide, about 7.6 per cent of lime oxide, 2.5 to 2.8 per cent magnesium oxide, 2.7 to 2.9 per cent potassium oxide, 1.3 to 5 per cent sodium oxide, and about 2.25 per cent sodium chloride. In a wet condition the clay contains as much as 40 per cent of moisture.

Three plants produced Portland cement in Utah in 1910. The Portland Cement Co. of Utah, at Salt Lake City, utilized cement rock and shale quarried at Parleys Canyon, 10 miles southeast of Salt Lake City; the Union Portland Cement Co., at Devils Slide, used a high calcium and low calcium limestone and shale; and the plant of the Ogden Portland Cement Co., at Bakers Spur, 5½ miles northwest of Brigham, utilized the marl and clay deposit above mentioned. All of these plants used coal as fuel. The two plants running on limestone and shale used the dry method and the marl plant used the wet method of producing Portland cement.

VERMONT.

Vermont contains extensive and important deposits of nonmagnesian limestones and marbles. These deposits are worked at present for building stone and lime manufacture. The limestones fall into two distinct groups, the lower of which contains the marbles worked in the vicinity of Rutland, Dorset, and Brandon. This is well known commercially as the "Vermont marble." The second group includes the semicrystalline limestones quarried in northwestern Vermont near Swanton, Highgate Springs, Winooski, and Leicester Junction. Both groups of limestones are probably for the most part of Ordovician age (Chazy and Trenton). Those in northwestern Vermont commonly range in color from dark gray to blue or almost black; the marbles are white and veined. Both are generally low in magnesia, and are well suited for use as Portland cement materials. Fuel, however, is expensive; there are no large local markets for cement; and satisfactory clays are rather difficult to obtain to mix with the limestone. On account of these commercial conditions no Portland cement industry has yet been established in Vermont.

VIRGINIA.

Geologically the most promising sources of Portland cement materials in Virginia fall into four divisions. Beginning with the lowest these are: (1) Ordovician limestones, principally of Trenton and Stones River age; (2) Lewistown limestone, of Devonian and Silurian age; (3) Greenbrier and Newman limestones, of Mississippian age; and (4) Tertiary shell beds or "marls." The great series of limestones of Ordovician age, which occupies most of the valley between the Blue Ridge and the Allegheny Range, belongs to the Shenandoah group. The basal portion of the group is of Cambrian age, and it is in most places unfit for use in Portland cement manufacture, owing to its high content of magnesium carbonate. The upper portion of the Shenandoah, of Ordovician age, is generally sufficiently low in magnesium carbonate to be worthy of consideration in this connection. The upper limestones are principally of Trenton and Stones River ages. For practical purposes they may be considered together under the general term of Ordovician limestones. They are exposed along the west side of the Shenandoah Valley and its southern continuations. In most localities they are overlain, or flanked to the west, by a heavy series of Ordovician shales, called in the northern and western portion of the valley the Martinsburg shale. Those limestone beds that show a high percentage of calcium carbonate are generally suitable, with the overlying shales, to be used for Portland cement.

The Lewistown limestone outcrops in the foothills of the Allegheny Range on the west side of the Great Valley through its entire extent in Virginia. This series of limestones is exceedingly variable, not only from place to place along the strike of the rocks, but from bed to bed in the same locality. In a very general way it may be said that the lower beds of the formation tend to have a shaly composition, and in many localities approach the composition of natural cement rocks. The beds higher in the formation are commonly less shaly, but in the upper portion cherty beds are present in many places, interbedded with pure limestones. The magnesia is confined to no particular portion of the formation. Wherever the formation outcrops along a coal-hauling railroad, such a locality may be worthy of consideration and of close examination. The Mississippian series consists largely of limestone in western Virginia. In West Virginia and Maryland this limestone is called the Greenbrier, and this name is also applicable in the greater portion of its extent in Virginia. In southwestern Virginia, however, the term Newman limestone is applied to a heavy limestone formation occupying approximately the same stratigraphic position as does the Greenbrier farther north, and the two limestones agree closely in composition as well as in stratigraphic position. The Mississippian limestone outcrops in rather narrow strips in several of the counties of southwestern Virginia. The most favorable localities for the manufacture of cement from this limestone are near Cumberland Gap, across the line in Tennessee, where the beds are accessible to two railroads and are within a few miles of the important Middlesboro coal district of Kentucky. Shale required for cement in connection with the Mississippian limestone can be obtained from four different geologic formations. Beginning with the lowest these are (1) the Chattanooga shale, of Devonian age, from 150 to 400 feet thick; (2) the Grainger shale, also of Devonian age, 50 to 125 feet thick; (3) the Pennington shale, of Mississippian age, 50 to 150 feet thick; and (4) the shales of the Pennsylvanian series, which outcrop in the Middlesboro basin northwest of Cumberland Mountain. Of these shales the Pennington is the least satisfactory, since it contains alternating layers of thin sandstone, and would probably yield too much silica to be of great value. Analyses of the Greenbrier and the Newman limestones in Virginia show generally less than 2 per cent of magnesium oxide, from 43 to 51 per cent of calcium oxide, from 1 to 3.5 per cent of alumina and iron oxide, and from 4.5 to 15 per cent of silica. In the eastern counties of Virginia certain Tertiary formations carry beds of so-called marl that are of great importance in connection with the development of the Portland cement industry in the State. The Tertiary shell beds, or "marls," of Virginia are not the same materials that are known as marl to the Portland cement industry of New York, Ohio, Indiana, and Michigan. Neither are they limy shale of the type termed by the older geologists, "marls." The use of a more practical term, such as shell beds, has been suggested by Eckel on account of its descriptive quality. The shell beds occur in both the Eocene and the Miocene series of the Tertiary, but only the Miocene are of importance at present. The Miocene shell beds outcrop in all the counties of the Coastal Plain, being best exposed in the counties of Nansemond, Isle of Wight, Surry, York, and Gloucester. Magnesium carbonate runs generally less than 1 per cent in the shell-bed material, the lime carbonate from 67 to 88 per cent, the iron oxide and alumina from 5 to 12 per cent, and the silica from 5 to 21 per cent. The irregularity in composition is probably due to the mode of origin of the beds. Originally they were made up of masses of shells of various mollusks, and at the time of their deposition some of the shell material became mixed with clay, and since their deposition many beds have become infiltrated with sand and clay to such an extent as to show relatively low percentages of lime carbonate. It is not difficult to find a small sample containing a high percentage of calcium carbonate, therefore it is necessary to exercise great care in obtaining average samples which shall represent the entire thickness of the bed and a considerable lateral extent of the bed as well. The great importance of these shell beds as cement materials is not due to superiority in composition, but, if the material is at all suitable, the location on tide water will generally make up for lack of great purity in composition. The beds most favorably situated for development lie on or near James and York Rivers.

Two Portland cement companies are operating in Virginia, namely, the Virginia Portland Cement Co., at Fordwick, and the Norfolk Portland Cement Corporation, at Berkley, near Norfolk. The raw materials used at Fordwick are Lewistown limestone and Devonian shale. The raw materials used at Berkley are derived from the Tertiary shell beds along and near James River, and from deposits of later sedimentary clays which at various points overlie these shell beds This is the first instance of the utilization of these shell beds for Portland cement manufacture. Both of these plants use coal for fuel.

WASHINGTON.

Limestone suitable for Portland cement manufacture is reported to be found only in the northern counties of the State, from Puget Sound to the Idaho boundary; that is, in San Juan, Whatcom, Snohomish, Skagit, King, Okanogan, Ferry, and Stevens counties. In San Juan County the deposits of most importance are at tidewater on San Juan and Orcas Islands. The principal deposits on San Juan Island are at Roche Harbor, at which point the largest lime works on the northwest Pacific coast are located. The limestone is crystalline and metamorphic, and has been thought to be of pre-Cretaceous age. Adjacent to the limestones there are large deposits of glacial sediments, which contain extensive beds of clay interbedded with sand. Some of the clay beds are known to be at least 40 feet in thickness, and are uncommonly free from gritty ingredients. In case these clays are not siliceous enough for use in cement manufacture, there are deposits of slate near at hand which might be utilized. In Whatcom County, in the vicinity of Kendall, there are a number of deposits of limestone and clay which afford the proper material for cement manufacture. An important outcrop of this limestone occurs in the form of a vertical cliff at a point about 3 miles from Kendall. The limestone is entirely crystalline and is a part of an extensive metamorphic series which has been greatly folded and crushed. A few miles west of the limestone deposits and along the railroad track are beds of glacial clay. One of these beds was drilled to a depth of 50 feet. The limestone is nearly pure, running 97.5 to nearly 99 per cent calicum carbonate, and the clay is apparently of a favorable composition for cement manufacture. In Skagit County large deposits of limestone and clay occur on the east side of Baker River, about three-fourths of a mile from its junction with Skagit River. This point is 40 miles from the mouth of the Skagit, a stream which is navigable at nearly all times of the year. The Seattle & Northern division of the Great Northern Railway also passes through this locality. The limestone is crystalline and nearly pure white in color. It is part of an extensive metamorphic series of unknown age. Slate adjoins the limestone, and these two formations strike a little west of north, the ledge of limestone dipping to the southwest at an angle of about 55 degrees. The outcrop is traceable for 600 feet along the strike and shows a width of 207 feet across the beds. The clay lies in horizontal beds in contact with the limestone, and is formed by silt brought down by Baker and Skagit Rivers. It is well stratified and finely assorted, and rests upon beds of gravel. It is light blue in color, and has an average depth of 165 feet. There is also considerable limestone near Mount Sauk, on Jackman Creek and Baker River. In Snohomish County limestone occurs at a number of places in the eastern half of the county, and has been quarried at a point 3 miles east of Granite Falls. This stone is crystalline and is a member of an extensive metamorphic series extending in a broad north-south belt. The associated rocks are chiefly slate and schists. This rock has been quarried for the manufacture of lime and for use in flux and in paper making. The metamorphic series of rocks occurring in Whatcom and Snohomish Counties continues into King County. In the vicinity of Snoqualmie Pass and at several points along the line of the Great Northern Railway, especially in the region about Baring, outcrops of crystalline limestone have been found. King County is particularly favored with clays of excellent quality. These clays occur chiefly in connection with the coal measures at Renton, Taylor, and Kummer. In the northern part of Okanogan County crystalline limestone has been discovered at many points, associated with slate, metamorphic sandstone, and conglomerate. The largest limestone areas are to the west and northwest of Riverside, where there are conspicuous cliffs of this rock covering an area of several square miles. On the eastern slope of Palmer Mountain are several prominent outcrops of light-gray limestone only partly crystalline. In Ferry County the largest limestone area is in the form of a long, narrow belt extending north-south across the country, and lies at the western foot of the granite divide separating Columbia and Kettle rivers from the streams to the west. This limestone is crystalline and associated with other metamorphic rocks, and near by clay and argillaceous limestone also occur, which might be utilized in cement manufacture. Stevens County contains large deposits of material necessary for cement manufacture. The rocks of the county are chiefly metamorphic in character, consisting mainly of limestone or marble, and slate and quartzite. The rocks have been greatly disturbed by folding, as well as by intrusion of igneous rocks. The limestones are usually entirely crystalline, and in several places yield marble of excellent quality. The only evidence as to the age of the rocks has been noted near Springdale, where the semicrystalline limestone contains coral remains, which indicates that it is Paleozoic, probably of Carboniferous age. Many of the limestones in Stevens County are high in magnesia, and careful field work will be necessary in order to determine the location and extent of the high-calcium limestones.

Two Portland cement plants were in operation in 1910 in Washington. The plant of the Washington Portland Cement Co. and that of the Superior Portland Cement Co. are located at Concrete, Skagit County. Both plants utilize practically the same types of raw material, the mixture being a metamorphic, highly crystalline limestone, with a Quaternary clay. It is reported that a third plant, that of the Inland Portland Cement Co., at Metaline Falls, Stevens County, will be in operation in the near future. Limestone, shale, and clay are the materials to be utilized at this plant. The limestone is reported to contain from 87 to 91 per cent calcium carbonate, from 3 to 3.5 per cent magnesium carbonate, and from 2 to 4.5 per cent alumina, iron oxide, and silica. Calcite carrying 97.5 per cent calcium carbonate is available 3 miles north of Metaline Falls. Two series of shales and one of terrace clays are also available within a few miles of the proposed site for the plant. Neither series of shales is alone satisfactory, but an appropriate mixture of the two is reported to effect a composition whereby any desired percentage of silica may be secured in the finished cement, irrespective of the lime content. One shale, that from Sullivan Creek, runs rather high in lime carbonate and low in silica, while that from Sand Creek runs high in silica and comparatively low in alumina, iron oxide, and calcium carbonate. Oil is used as fuel in the two existing plants, and it is proposed to use coal as fuel in the plant of the Inland Co., as this is to be located in the extreme eastern part of the State.

WEST VIRGINIA.

Four geologic divisions in West Virginia afford limestones worthy of consideration as Portland cement materials. Beginning with the lowest they are: (1) the Ordovician limestones, principally of Trenton and Stones River age; (2) the Lewistown limestone, of Devonian and Silurian age; (3) the Greenbrier limestone, of Mississippian age; and (4) the Pennsylvanian ("Coal Measures") limestone; they constitute practically the same series, with the exception of the shell beds, that is present in Virginia. The most important of these limestones are the Greenbrier and the Ordovician. The only large area of Ordovician limestone in West Virginia lies in Jefferson and Berkeley counties, in the extreme northeastern angle of the State. These rocks are a portion of the great series of limestones that occupy the valley between the Blue Ridge and the Allegheny Mountains, and are known as the Shenandoah group. These rocks have also been discussed in the sections on the cement resources of Maryland and Virginia. In West Virginia the limestone at the top of the Shenandoah group is well developed, and carries heavy beds of low-magnesia limestone. The rock is also low in silica, alumina, and iron oxide, so that the calcium carbonate runs generally between 90 and 97 per cent. The Lewistown limestone has a comparatively small area of outcrop in West Virginia, but at certain points its location gives it advantages which render it worthy of serious consideration. In Mercer and Monroe counties the limestone of this age, which here is included in the Giles formation, is exposed along the lines of the coal-carrying railroads, at points near the coal fields. In composition this Devonian and Silurian limestone in places resembles a cement rock somewhat similar to that of the Lehigh district, and in other places it is nearly pure. The Greenbrier limestone covers large areas in West Virginia, and reaches its greatest development in the type area of Greenbrier County. Throughout its entire extent in West Virginia, the Greenbrier consists almost entirely of pure nonmagnesian limestone, though some shaly and magnesian beds occur. The high calcium portions of this stone carry generally between 90 and 98 per cent calcium carbonate, and the argillaceous beds carry from 67 to 78 per cent calcium carbonate with correspondingly high percentages of silica. The Pennsylvanian series in West Virginia contains a number of more or less persistent beds of limestone. These limestones are normally low enough in magnesium carbonate to be considered valuable for use as Portland cement material. They are rarely very pure, however, commonly ranging from 80 to 90 per cent calcium carbonate, while their silica, alumina, and iron oxide together may range from 5 to 15 per cent or more. The individual beds are commonly not very thick, and rarely outcrop in such a manner as to admit of cheap, open quarrying. To offset these disadvantages the limestones are found in the immediate vicinity of developed coal fields, as, for instance, in Kanawha County.

Only one Portland cement plant is in operation in West Virginia, that of the Alpha Portland Cement Co., at Manheim. This plant utilizes beds of cement rock in the Greenbrier limestone, and uses coal for kiln fuel.

WISCONSIN.

Wisconsin contains thick and widely distributed beds of limestone in both the Ordovician and the Silurian systems. The greater part of these beds, however, are highly magnesian. The only fairly thick and extensive beds of low-magnesia limestone in Wisconsin appear to occur in the lead and zinc region in the southwestern part of the State, and are confined to the upper part of the Platteville limestone (Ordovician). There is in this formation a generally thin bed of relatively pure limestone locally developed. It is known in this region as the "glass rock," and outcrops near Mineral Point and Platteville. This rock ranges from 84 to 98 per cent lime carbonate, and from 1.6 to 5.3 per cent magnesium carbonate. This rock is generally not very well situated for quarrying, as it is usually overlain by heavy magnesian beds. In addition to the Paleozoic limestones just mentioned, there is a possibility that Quaternary marl may yet prove of importance as a Portland cement material. Many small lakes occur in Wisconsin within the glaciated area, and some of them contain deposits of marl, as in Michigan, Ohio, Indiana, and other States within the glacial limits. An analysis of marl from one of the Wisconsin deposits shows that the material contains over 7 per cent of magnesium carbonate. This is of significance because the marls were ultimately derived from local limestones scraped and ground by the glaciers, and it may be expected that the marls of Wisconsin will, therefore, carry larger percentages of magnesia than marls overlying areas of purer limestones than are found in Wisconsin.

No Portland cement plant has yet been established in Wisconsin.

WYOMING.

The cement possibilities of two areas in Wyoming have been investigated by the United States Geological Survey, and materials in the vicinity of Newcastle and Cheyenne have been determined. The rocks in the vicinity of Newcastle were found to be of two types, one a fairly high-calcium rock containing less than 1 per cent of magnesia, the other a rock carrying some 18 per cent silica and about 38 per cent calcium oxide, which indicates that it is to be classed as a "cement rock." Less pure limestones were found near Iron Mountain, about 40 miles from Cheyenne. The shales occurring near Newcastle were found to be, with one exception, fairly well suited for mixing with the limestone in that locality. The shales from near Cheyenne were equally good, but owing to the character of the limestone in the Cheyenne district a satisfactory mixture would be rather difficult to obtain. The Newcastle locality appears to have the advantage in every particular, especially with regard to fuel supply. Thus far no Portland cement plant has been established in Wyoming.

PUBLICATIONS ON CEMENT MATERIALS.

STATE GEOLOGICAL SURVEYS.

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, Georgia, Illinois, Indiana, Iowa, Maryland, Michigan, Mississippi, Arkansas, Missouri, New Jersey, New York, North Dakota, Ohio, Oklahoma, South Dakota, Vermont, Virginia, Washington, and West Virginia, and certain other States have done a little work on their cement materials.

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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 1910 in the clay-working industries was, on the whole, one of fair progress; the value of the products was the largest ever made, the total being $170,115,974, as compared with $166,321,213 in 1909, an increase of $3,794,761, or 2.28 per cent. The increase in 1909 over 1908 was the largest ever recorded, $33,123,451, or 24.87 per cent. This, however, was due to the recovery to normal conditions from the financial depression.

Of the two great divisions of the industry—(1) brick and tile and (2) pottery—the latter showed the greater improvement, the increase in 1910 being 0.78 per cent and 8.81 per cent, respectively. In the brick and tile industry, building brick of all kinds except fancy or ornamental declined in value, while drain tile, sewer pipe, architectural terra cotta, fireproofing, stove lining, and fire brick showed gains. In the pottery industry every item of the classification except one, which was of minor importance, showed an increase. The imports of pottery increased but little and the proportion of domestic production to consumption, 77.08 per cent, was the highest ever recorded. It has been estimated that as late as 1875 the domestic production was but 15 per cent of the consumption. The exports of high-grade domestic pottery, though small, showed an increase, and the value of exports of all clay products increased 31.34 per cent.

The average price for the whole country per thousand of building brick of various kinds increased in every instance where quantity was reported. The most noteworthy example of this was in Illinois, where the price of common brick advanced from $4.72 in 1909 to $5.76 in 1910. This was due to the increase in Cook County, where it rose from $4.20 in 1909 to $5.62 in 1910. The average value of product per firm reporting in 1910 was $34,612 compared with $32,818 in 1909.

The year opened with the brightest of prospects, the enormous production of 1909 having given hopes that 1910 would show a still greater gain, but the record shows that these hopes were not to be fully realized, though the total value of the clay products slightly exceeds that of 1909. In the brick and tile industries this was barely accomplished. In fact the most important of these products, building brick such as are used in the less pretentious buildings, showed a decrease from 1909, while those most used in the higher class structures, such as fireproofing, architectural terra cotta, and the clay products used in the engineering arts, showed gains.

There were no strikes of consequence in the clay-working industries during 1910. In fact these industries are singularly free from serious labor disturbances. There are of course, from time to time, local strikes which are generally quickly settled.

ACKNOWLEDGMENTS.

Again the writer, on behalf of the Survey, desires to thank the clay workers of the country for their cooperation, without which this report would be impossible.

The State geological surveys of Alabama, Georgia, Illinois, Iowa, Kansas, Kentucky, Maryland, Michigan, Missouri, New Jersey, North Carolina, Oregon, Virginia, and Wisconsin have cooperated in the collection of the statistics in these States, the completeness of the returns being due largely to their efforts.

Thanks are also extended to the clay-working press for its support and appreciation and to the officials who have supplied information concerning the building operations of the various cities of the country.

PRODUCTION.

In the following table will be found a statement of the value of the clay products of the United States in 1909 and 1910:

Value of the products of clay in the United States in 1909 and 1910, by States and Territories.

State or Territory.	1909			1910		
	Brick and tile.	Pottery.	Total.	Brick and tile.	Pottery.	Total.
Alabama	$1,663,788	$36,339	$1,700,127	$1,645,313	$22,246	$1,667,559
Arizona	107,940	....	107,940	126,777	....	126,777
Arkansas	600,550	26,474	627,024	550,105	28,350	578,455
California	4,312,590	124,575	4,437,165	4,744,968	97,423	4,842,391
Colorado	1,994,798	54,226	2,049,024	1,982,827	50,887	2,033,714
Connecticut and Rhode Island	1,515,595	(a)	1,515,595	1,568,486	(a)	1,568,486
Delaware	231,505	....	231,505	216,555	....	216,555
District of Columbia	214,489	(a)	214,489	242,861	(a)	242,861
Florida	298,620	....	298,620	237,268	....	237,268
Georgia	2,265,121	29,380	2,294,501	2,510,740	21,298	2,532,038
Idaho and Nevada	416,695	....	416,695	347,437	....	347,437
Illinois	13,505,898	838,555	14,344,453	14,331,414	844,747	15,176,161
Indiana	6,744,295	900,928	7,645,223	7,143,306	956,704	8,100,010
Iowa	4,846,706	51,990	4,898,696	5,310,706	17,535	5,328,241
Kansas	2,709,822	(a)	2,709,822	2,661,527	(a)	2,661,527
Kentucky	2,332,475	146,397	2,478,872	2,418,116	149,421	2,567,537
Louisiana	528,261	(a)	528,261	546,873	(a)	546,873
Maine	635,667	(a)	635,667	599,881	(a)	599,881
Maryland	1,400,380	320,432	1,720,812	1,614,348	233,925	1,848,273
Massachusetts	1,631,858	256,028	1,887,886	1,469,018	238,395	1,707,413
Michigan	1,947,059	95,439	2,042,498	2,083,525	112,697	2,196,222
Minnesota	1,755,438	(a)	1,755,438	1,901,296	(a)	1,901,296
Mississippi	779,009	19,341	798,350	613,009	19,990	632,999
Missouri	7,367,061	73,122	7,440,183	7,058,705	29,061	7,087,766
Montana	451,389	(a)	451,389	411,824	(a)	411,824
Nebraska	1,146,449	....	1,146,449	938,827	....	938,827
New Hampshire	552,215	(a)	552,215	566,121	(a)	566,121
New Jersey	9,380,958	7,791,136	17,172,094	9,245,854	8,588,455	17,834,309
New Mexico	182,755	(a)	182,755	129,275	(a)	129,275
New York	10,270,227	1,887,209	12,157,436	9,778,288	2,093,661	11,871,949
North Carolina	1,283,902	18,709	1,302,611	1,208,674	14,990	1,223,664
North Dakota	269,324	....	269,324	227,455	....	227,455
Ohio	16,929,885	13,416,356	30,346,241	17,231,236	14,294,712	31,525,948
Oklahoma	1,032,314	....	1,032,314	920,921	....	920,921
Oregon	827,963	(a)	827,963	876,632	(a)	876,632
Pennsylvania	19,403,944	1,782,769	21,186,713	19,814,355	2,279,930	22,094,285
Porto Rico	34,506	(a)	34,506	27,773	(a)	27,773

a Included in "Other States."

Value of the products of clay in the United States in 1909 and 1910, by States and Territories—Continued.

State or Territory.	1909.			1910.		
	Brick and tile.	Pottery.	Total.	Brick and tile.	Pottery.	Total.
South Carolina	$751,037	$1,967	753,004	$696,600	$7,990	$704,590
South Dakota	68,660		68,660	71,200		71,200
Tennessee	1,575,262	73,610	1,648,872	1,205,108	209,180	1,414,288
Texas	3,026,035	122,428	3,148,463	2,744.845	119,085	2,863.930
Utah	874,159	(a)	874,159	864,258	(a)	864,258
Vermont	83,360		83,360	89,253		89,253
Virginia	1,919,771	36,746	1,956,517	1,793,270	46,417	1,839,687
Washington	3,044,275	16,211	3,060,486	3,023,854	(a)	3.023,854
West Virginia	1,159,627	2,350,470	3,510,097	1,322,457	2,675,588	3,998,045
Wisconsin	1,130,380	9,209	1,139,589	1,167,918	8,965	1,176,883
Wyoming	67,755		67,755	50,237		50,237
Other States		569,395	569,395		623,026	623,026
Total	135,271,772	31,049,441	166,321,213	136,331,296	33,784,678	170,115,974
Per cent of total	81.33	18.67	100.00	80.15	19.85	100.00

a Included in "Other States."

This table shows that the brick and tile products as classified by this Survey continue to constitute approximately four-fifths and the pottery products one-fifth of the entire product. These proportions have been maintained for many years. Every State and Territory, except Alaska and Hawaii, is a producer of burned clay. 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 statistics 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 1909 and 1910, showing increase or decrease, with percentage of increase or decrease.

State or Territory.	1909	1910	Increase (+) or decrease (—) in 1910.	Percentage of increase (+) or decrease (—) in 1909.
Alabama	$1,700,127	$1,667,559	— $32,568	— 1.92
Arizona	107,940	126,777	+ 18,837	+17.45
Arkansas	627,024	578,455	— 48,569	— 7.75
California	4,437,165	4,842,391	+ 405,226	+ 9.13
Colorado	2,049,024	2,033,714	— 15,310	— .75
Connecticut and Rhode Island	1,515,595	1,568,486	+ 52,891	+ 3.49
Delaware	231,505	216,555	— 14,950	— 6.46
District of Columbia	214,489	242,861	+ 28,372	+13.23
Florida	298,620	237,268	— 61,352	—20.55
Georgia	2,294,501	2,532,038	+ 237,537	+10.35
Idaho and Nevada	416,695	347,437	— 69,258	—16.62
Illinois	14,344,453	15,176,161	+ 831,708	+ 5.80
Indiana	7,645,223	8,100,010	+ 454,787	+ 5.95
Iowa	4,898,696	5,328,241	+ 429,545	+ 8.77
Kansas	2,709,822	2,661,527	— 48,295	— 1.78
Kentucky	2,478,872	2,567,537	+ 88,665	+ 3.58
Louisiana	528,261	546,873	+ 18,612	+ 3.52
Maine	635,667	599,881	— 35,786	— 5.63
Maryland	1,720,812	1,848,273	+ 127,461	+ 7.41
Massachusetts	1,887,886	1,707,413	— 180,473	— 9.56
Michigan	2,042,498	2,196,222	+ 153,724	+ 7.53
Minnesota	1,755,438	1,901,296	+ 145,858	+ 8.31
Mississippi	798,350	632,999	— 165,351	—20.71
Missouri	7,440,183	7,087,766	— 352,417	— 4.74
Montana	451,389	411,824	— 39,565	— 8.77
Nebraska	1,146,449	938,827	— 207,622	—18.11
New Hampshire	552,215	566,121	+ 13,906	+ 2.52
New Jersey	17,172,094	17,834,309	+ 662,215	+ 3.86
New Mexico	182,755	129,275	— 53,480	—29.26
New York	12,157,436	11,871,949	— 285,487	— 2.35
North Carolina	1,302,611	1,223,664	— 78,947	— 6.06

Value of the clay products of the United States, by States and Territories, in 1909 and 1910, showing increase or decrease, with percentage of increase or decrease—Continued.

State or Territory.	1909	1910	Increase (+) or decrease (−) in 1910.	Percentage of increase (+) or decrease (−) in 1909.
North Dakota	$269,324	$227,455	− $41,869	−15.55
Ohio	30,346,241	31,525,948	+1,179,707	+ 3.89
Oklahoma	1,032,314	920,921	− 111,393	−10.79
Oregon	827,963	876,632	+ 48,669	+ 5.88
Pennsylvania	21,186,713	22,094,285	+ 907,572	+ 4.28
Porto Rico	34,506	27,773	− 6,733	−19.51
South Carolina	753,004	704,590	− 48,414	− 6.43
South Dakota	68,660	71,200	+ 2,540	+ 3.70
Tennessee	1,648,872	1,414,288	− 234,584	−14.23
Texas	3,148,463	2,863,930	− 284,533	− 9.04
Utah	874,159	864,258	− 9,901	− 1.13
Vermont	83,360	89,253	+ 5,893	+ 7.07
Virginia	1,956,517	1,839,687	− 116,830	− 5.97
Washington	3,060,486	3,023,854	− 36,632	− 1.20
West Virginia	3,510,097	3,998,045	+ 487,948	+13.90
Wisconsin	1,139,589	1,176,883	+ 37,294	+ 3.27
Wyoming	67,755	50,237	− 17,518	−25.85
Other States	a 569,395	a 623,026	+ 53,631	+ 9.42
Total	166,321,213	170,115,974	+3,794,761	+ 2.28

a Includes pottery products which could not be separately classified without disclosing individual figures.

Of the States and Territories represented by the 48 totals 26 showed losses, as compared with 1909, and 22 showed gains. The largest actual loss was sustained by Missouri, $352,417, and the largest proportionate loss by New Mexico, 29.26 per cent. The largest gain was in Ohio, $1,179,707, and the largest proportionate gain in Arizona, 17.45 per cent. In 1909 but 5 States showed losses from 1908, namely, California, District of Columbia, Louisiana, Mississippi, and Vermont. The losses in 1910 were not confined to any section; but the South seems to have suffered more than any other section, as 11 southern States showed decreases and 5 increases. The losses in these 11 States constituted 55.37 per cent of the total losses. Of the first 10 States in value of products, only 2 showed decreases, New York and Missouri.

Value of the products of clay in the United States in 1909 and 1910, with increase or decrease.

Product.	1909	1910	Increase (+) or decrease (−) in 1910.	Percentage of increase (+) or decrease (−) in 1910.
Common brick	$57,251,115	$55,219,551	−$2,031,564	− 3.55
Vitrified paving brick or block	11,269,586	11,004,666	− 264,920	− 2.35
Front brick	9,712,219	8,590,057	− 1,122,162	−11.55
Fancy or ornamental brick	174,073	179,505	+ 5,432	+ 3.12
Enameled brick	993,902	832,225	− 161,677	−16.27
Drain tile	9,799,158	10,389,822	+ 590,664	+ 6.03
Sewer pipe	10,322,324	11,428,696	+ 1,106,372	+10.72
Architectural terra cotta	6,251,625	6,976,771	+ 725,146	+11.60
Fireproofing	4,466,708	5,110,597	+ 643,889	+14.42
Tile (not drain)	5,291,963	5,240,644	− 51,319	− .97
Stone lining	423,583	503,806	+ 80,223	+18.94
Fire brick	16,620,695	18,111,474	+ 1,490,779	+ 8.97
Miscellaneous	2,694,821	2,743,482	+ 48,661	+ 1.81
Total brick and tile	135,271,772	136,331,296	+ 1,059,524	+ .78
Total pottery	31,049,441	33,784,678	+ 2,735,237	+ 8.81
Grand total	166,321,213	170,115,974	+ 3,794,761	+ 2.28

This table shows that five products sustained decreases in 1910, none of them being very large, though two of the most important products, namely, common brick and vitrified brick or block, showed decreases.

The greatest of all clay products in point of value and geographic distribution, common brick, showed the largest decrease, $2,031,564, or 3.55 per cent. This product in 1909 showed a large gain over 1908. Vitrified paving brick showed a decrease of $264,920, or 2.35 per cent.

Drain tile showed an increase of $590,664, or 6.03 per cent. The Middle West continues to be the principal field of usefulness of this material. Sewer pipe, which showed a decrease in 1909, regained its loss and exceeded its 1908 product by $424,965, or 3.86 per cent.

Fire brick showed a larger gain over 1909 than any other product, $1,490,779, or 8.97 per cent. In 1909 silica brick was included with clay fire brick, as it was impossible to separate them; therefore, for 1910 for comparative purposes, they are combined. For 1910 a separate inquiry was made for silica brick, and its value as reported was $3,289,028.

The total increases were: Brick and tile, $1,059,524, or 0.78 of 1 per cent, and pottery $2,735,237, or 8.81 per cent, a total of $3,794,761, or 2.28 per cent. In 1909 the increases were: 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.

The following table shows the value of the products of clay in the United States from 1901 to 1910, inclusive, by varieties of product, together with the total for each year and the number of operating firms reporting:

Products of clay in the United States, 1901–1910, 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.
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
1910	4,915	9,221,517	55,219,551	5.99	968,000	11,004,666	11.37

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.					
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
1910	697,857	8,590,057	12.31	179,505	832,225	18,111,474	503,806	10,389,822

[a] Stove lining is included in fire brick in 1903; in miscellaneous in 1904.

Products of clay in the United States, 1901–1910, by varieties—Continued.

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.
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
1910	11,428,696	6,976,771	5,110,597	5,240,644	2,743,482	136,331,296	33,784,678	170,115,974

This table shows the growth of the clay-working industries during 10 years. The total value of these products increased from $110,211,587 in 1901 to $170,115,974 in 1910, an increase of $59,904,387, or 54.35 per cent. In only three years has there been a decrease, and in one, 1904, it was so small as to be negligible. In 1908 the greatest decrease—$25,744,607—and in 1909 the greatest increase—$33,123,451—was recorded. The maximum value was reached in 1910 in four brick and tile products—fire brick, drain tile, architectural terra cotta, and fireproofing; pottery also reached its maximum value.

The maximum quantity of common brick was reached in 1906 and the maximum value in 1905. The 1910 product was within 805,522,000 brick, or 8.03 per cent, of the maximum, and the value within $6,174,832, or 10.06 per cent, of the maximum. The average price per thousand ranged from $5.66 in 1901 to $6.25 in 1905.

Vitrified paving brick, after an almost steady gain in quantity for nine years, showed a small decrease in 1910—55,654,000, or 5.44 per cent. In average value per thousand it ranged from $9.06 in 1901 to $11.37 in 1910.

Front brick reached its maximum quantity in 1909—816,164,000—and showed a decrease in 1910 of 118,307,000 brick, or 14.50 per cent. By a steady increase, except in 1907 and 1908, it more than doubled its value from 1901 to 1909, the increase in 1909 being very large, but it fell off again in 1910. The price per thousand ranged from $11.34 in 1901 to $13.12 in 1905, with $12.31 as the average for 1910.

Enamel brick, after more than doubling its value from 1901 to 1909, showed a decrease in 1910.

Fire brick attained its maximum value in 1910, nearly doubling that of 1901.

Drain tile is the only product to show a steady gain throughout the 10 years covered by the table, its increase in value in this period being $7,246,821, or 230.57 per cent. For the first time it reached a value of over $10,000,000 in 1910.

Sewer pipe gained steadily in value from 1901 to 1907, and then for two years it showed a decline; but in 1910 it almost equaled its maximum output—that for 1907.

Architectural terra cotta was one of the four brick and tile products to show its maximum value in 1910. In the 10 years it has shown decreases in only two years, 1904 and 1908.

Fireproofing was another product to show its maximum in 1910—$5,110,597. The next highest value reported was in 1906, when it was $4,586,538—a gain in 1910 of $524,059, or 11.43 per cent.

Tile, not drain, has varied more or less; it showed a large gain in 1909 and a small decrease in 1910—$51,319, or 0.97 per cent.

RANK OF STATES.

The following table shows the rank of States in the 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 1909 and 1910.

State.	1909 Rank.	1909 Number of operating firms reporting.	1909 Value.	1909 Percentage of total product.	1910 Rank.	1910 Number of operating firms reporting.	1910 Value.	1910 Percentage of total product.
Ohio	1	685	$30,346,241	18.25	1	683	$31,525,948	18.53
Pennsylvania	2	457	21,186,713	12.74	2	451	22,094,285	12.99
New Jersey	3	165	17,172,094	10.32	3	167	17,834,309	10.48
Illinois	4	379	14,344,453	8.62	4	346	15,176,161	8.92
New York	5	243	12,157,436	7.31	5	240	11,871,949	6.98
Indiana	6	348	7,645,223	4.60	6	249	8,100,010	4.76
Missouri	7	156	7,440,183	4.47	7	150	7,087,766	4.17
Iowa	8	247	4,898,696	2.95	8	232	5,328,241	3.13
California	9	99	4,437,165	2.67	9	107	4,842,391	2.85
West Virginia	10	50	3,510,097	2.11	10	56	3,998,045	2.35
Washington	12	65	3,060,486	1.84	11	65	3,023,854	1.78
Texas	11	113	3,148,463	1.89	12	124	2,863,930	1.68
Kansas	13	58	2,709,822	1.63	13	59	2,661,527	1.57
Kentucky	14	99	2,478,872	1.49	14	95	2,567,537	1.51
Georgia	15	105	2,294,501	1.38	15	109	2,532,038	1.49
Michigan	17	122	2,042,498	1.23	16	118	2,196,222	1.29
Colorado	16	73	2,049,024	1.23	17	77	2,033,714	1.20
Minnesota	20	80	1,755,438	1.06	18	84	1,901,296	1.12
Maryland	21	59	1,720,812	1.03	19	55	1,848,273	1.09
Virginia	18	89	1,956,517	1.18	20	84	1,839,687	1.08
Massachusetts	19	72	1,887,886	1.14	21	71	1,707,413	1.00
Alabama	22	100	1,700,127	1.02	22	87	1,667,559	.98
Connecticut and Rhode Island	24	42	1,515,595	.91	23	42	1,568,486	.92
Tennessee	23	100	1,648,872	.99	24	97	1,414,288	.83
North Carolina	25	187	1,302,611	.78	25	184	1,223,664	.72
Wisconsin	27	106	1,139,589	.69	26	112	1,176,883	.69
Nebraska	26	79	1,146,449	.69	27	78	938,827	.55
Oklahoma	28	39	1,032,314	.62	28	46	920,921	.54
Oregon	30	68	827,963	.50	29	66	876,632	.52
Utah	29	37	874,159	.53	30	37	864,258	.51
South Carolina	32	52	753,004	.45	31	49	704,590	.41
Mississippi	31	79	798,350	.48	32	71	632,999	.37
Maine	33	49	635,667	.38	33	55	599,881	.35
Arkansas	34	50	627,024	.38	34	48	578,455	.34
New Hampshire	35	29	552,215	.33	35	29	566,121	.33
Louisiana	36	54	528,261	.32	36	54	546,873	.32
Montana	37	22	451,389	.27	37	26	411,824	.24
Idaho and Nevada	38	41	416,695	.25	38	49	347,437	.20
District of Columbia	42	9	214,489	.13	39	8	242,861	.14
Florida	39	22	298,620	.18	40	23	237,268	.14
North Dakota	40	13	269,324	.16	41	16	227,455	.13
Delaware	41	22	231,505	.14	42	22	216,555	13
New Mexico	43	17	182,755	.11	43	16	129,275	.08
Arizona	44	20	107,940	.06	44	19	126,777	.08
Vermont	45	8	83,360	.05	45	7	89,253	.05
South Dakota	46	10	68,660	.04	46	11	71,200	.04
Wyoming	47	13	67,755	.04	47	14	50,237	.03
Porto Rico	48	36	34,506	.02	48	27	27,773	.02
Other States	......	....	[a] 569,395	.34	......	....	[a] 623,026	.37
Total	......	5,068	166,321,213	100.00	......	4,915	170,115,974	100.00

[a] Undistributed pottery products.

The value of the clay products ranged by States in 1910 from $27,773, or 0.02 per cent of the total, in Porto Rico to $31,525,948, or 18.53 per cent, in Ohio. Ohio has been the leading clay-working State in the Union since figures were compiled by this office. The value of Ohio's output in 1910 was $9,431,663, or 42.69 per cent, greater than that of Pennsylvania, the second State, whose output was valued at $22,094,285, or 12.99 per cent of the total. New Jersey was the third State in both years, reporting 10.32 per cent of the total in 1909 and 10.48 per cent in 1910. There was no change in the relative ranks of the first 10 States, and there were but slight changes in the relative ranks of the other States. Washington, which was twelfth in 1909, became eleventh in 1910, displacing Texas. Minnesota rose from twentieth to eighteenth, and Maryland from twenty-first to nineteenth. Colorado fell from sixteenth to seventeenth, and Massachusetts from nineteenth to twenty-first. The first 10 States reported for 1910 wares valued at $127,859,105, or 75.16 per cent of the whole; for 1909 they reported $123,138,301, or 74.04 per cent. The first five States reported wares in 1910 valued at $98,502,652, or 57.90 per cent of the total, as compared with $95,206,937, or 57.24 per cent of the total, in 1909.

The number of operating firms reporting showed a decrease from 5,068 in 1909 to 4,915 in 1910, a loss of 153. No attempt is made to show the number of yards or plants, but merely the number of operating firms reporting. The number of plants is considerably larger than the number of operating firms reporting, as many firms have more than one plant, and some as many as 25; nor are any idle plants included, the number of which was considerable in 1910.

BRICK AND TILE.

PRODUCTION.

The tables following show the output and value of the building brick and other structural products of clay, and of the fire brick, paving brick, and other clay products used in engineering work, the rank of the States in these products, and the percentage of the total value of each State in 1909 and 1910.

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.		Average price per thousand.	Fancy or ornamental brick (value).	Drain-tile (value).	Sewer pipe (value).	Architectural terra cotta (value).	Fire-proofing (value).
		Quantity.	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.	Percentage 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.

Brick and tile products in the United States in 1910.

Rank.	State.	Common brick.			Vitrified brick or block.		
		Quantity.	Value.	Average price per thousand.	Quantity.	Value.	Average price per thousand.
		Thousands.			*Thousands.*		
19	Alabama	135,785	$746,961	$5.50	19,772	$236,516	$11.96
44	Arizona	12,740	115,977	9.10			
35	Arkansas	67,583	466,707	6.91	(a)	(a)	10.71
9	California	280,265	1,694,312	6.05	8,538	140,130	16.41
16	Colorado	128,711	852,986	6.63	(a)	(a)	14.15
21	Connecticut and Rhode Island	240,234	1,454,471	6.05	(a)	(a)	14.62
42	Delaware	21,940	174,139	7.94			
39	District of Columbia	28,494	202,136	7.09			
40	Florida	42,195	234,524	5.56			
13	Georgia	305,025	1,620,174	5.31	(a)	(a)	11.11
38	Idaho and Nevada	39,271	322,862	8.22	(a)	(a)	25.00
3	Illinois	1,196,526	6,896,836	5.76	115,903	1,415,355	12.21
6	Indiana	234,297	1,402,154	5.98	61,034	682,888	11.19
8	Iowa	149,914	1,088,266	7.26	19,887	239,283	12.03
12	Kansas	218,353	922,940	4.22	118,950	1,089,978	9.16
14	Kentucky	115,890	743,732	6.42	(a)	(a)	12.74
36	Louisiana	80,555	502,330	6.24			
33	Maine	54,641	367,903	6.73	(a)	(a)	25.02
20	Maryland	164,795	1,051,381	6.38	(a)	(a)	16.96
22	Massachusetts	165,315	1,120,924	6.78			
15	Michigan	232,551	1,363,316	5.86	9,080	116,446	12.82
17	Minnesota	182,895	1,104,898	6.04			
32	Mississippi	91,065	527,981	5.80			
7	Missouri	201,281	1,284,997	6.38	56,703	647,441	11.42
37	Montana	26,124	254,282	9.73	(a)	(a)	20.00
27	Nebraska	119,017	791,351	6.65	(a)	(a)	8.88
34	New Hampshire	77,567	566,121	7.30			
5	New Jersey	401,103	2,215,628	5.52			
43	New Mexico	7,929	63,703	8.03	(a)	(a)	12.06
4	New York	1,380,084	6,897,438	5.00	21,662	334,432	15.44
24	North Carolina	167,966	1,039,319	6.19			
41	North Dakota	17,941	140,862	7.85			
2	Ohio	409,773	2,507,742	6.12	289,817	2,876,157	9.92
28	Oklahoma	131,146	763,236	5.82	11,959	114,315	9.56
29	Oregon	58,588	482,333	8.23			
1	Pennsylvania	828,703	5,371,707	6.48	101,330	1,204,724	11.89
48	Porto Rico	2,915	25,109	8.61			
31	South Carolina	115,128	657,801	5.71			
46	South Dakota	6,050	57,150	9.45			
25	Tennessee	140,878	826,533	5.87	(a)	(a)	10.80
11	Texas	271,640	1,779,062	6.55	(a)	(a)	13.67
30	Utah	54,537	411,415	7.54	(a)	(a)	24.18
45	Vermont	9,633	58,766	6.10			
18	Virginia	229,982	1,460,460	6.35			
10	Washington	130,634	956,510	7.32	(a)	(a)	18.87
23	West Virginia	77,916	508,422	6.53	46,098	564,578	12.25
26	Wisconsin	161,083	1,071,457	6.65			
47	Wyoming	4,859	50,237	10.34			
	Other States[b]				87,267	1,342,423	15.38
	Total	9,221,517	55,219,551	5.99	968,000	11,004,666	11.37
	Per cent of brick and tile products		40.51			8.07	
	Per cent of total of clay products		32.46			6.47	

[a] Included in "Other States."
[b] Includes all products made by less than 3 producers in 1 State.

Brick and tile products in the United States in 1910—Continued.

Rank.	State.	Front brick.			Fancy or ornamental brick.	Drain-tile.	Sewer pipe.	Architectural terra cotta.	Fireproofing.
		Quantity.	Value.	Average price per thousand.	Value.	Value.	Value.	Value.	Value.
		Thousands.							
19	Alabama	(a)	(a)	$15.96		$3,773	(a)		(a)
44	Arizona	(a)	(a)	20.00					
35	Arkansas	(a)	(a)	11.02		4,258			
9	California	11,475	$285,468	24.88	$48,572	55,386	$1,031,061	$678,249	$151,503
16	Colorado	30,334	368,538	12.15	(a)	18,066	(a)		32,565
21	Connecticut and Rhode Island	(a)	(a)	15.75	(a)				
42	Delaware	(a)	(a)	19.49	(a)	(a)			
39	District of Columbia					(a)	(a)		
40	Florida					(a)			
13	Georgia	13,649	129,393	9.48	(a)	8,920	373,387	(a)	19,354
38	Idaho and Nevada	675	13,850	20.52		(a)			
3	Illinois	22,138	274,699	12.41	10,875	1,613,698	538,633	1,680,438	552,905
6	Indiana	46,691	478,627	10.25	(a)	2,071,564	406,543	(a)	466,877
8	Iowa	8,142	103,276	12.68		3,337,851	313,430		200,965
12	Kansas	25,814	223,875	8.67	(a)	50,726	(a)	(a)	(a)
14	Kentucky	10,238	99,532	9.72	(a)	66,217	(a)		(a)
36	Louisiana	(a)	(a)	10.55		(a)			
33	Maine	(a)	(a)	10.76		(a)	(a)		
20	Maryland	260	3,953	15.20	(a)	5,899		(a)	
22	Massachusetts	(a)	(a)	15.44					(a)
15	Michigan	2,209	27,533	12.46		348,205	(a)		
17	Minnesota	7,240	88,000	12.15		160,706	(a)		93,731
32	Mississippi	1,431	15,963	11.16		68,065			
7	Missouri	38,428	516,505	13.44	23,673	121,068	1,210,348	(a)	146,931
37	Montana	344	6,146	17.87		(a)	(a)		(a)
27	Nebraska	(a)	(a)	16.00		(a)			(a)
34	New Hampshire								
5	New Jersey	47,451	609,845	12.85	(a)	23,147	(a)	2,000,039	1,582,101
43	New Mexico	2,749	32,977	12.00					(a)
4	New York	9,229	137,748	14.93	(a)	272,836	136,576	1,108,371	210,954
24	North Carolina	550	5,800	10.55		9,555	(a)		(a)
41	North Dakota	4,642	77,808	16.76					
2	Ohio	134,759	1,489,094	11.05	32,995	1,869,823	3,289,537		934,960
28	Oklahoma	2,682	35,288	13.16					
29	Oregon	5,580	137,040	24.56		51,516	(a)		(a)
1	Pennsylvania	171,415	2,001,967	11.68	35,768	11,480	583,418	472,150	300,187
48	Porto Rico				(a)				(a)
31	South Carolina	(a)	(a)	14.20		(a)			
46	South Dakota	(a)	(a)	11.20	(a)				
25	Tennessee	10,119	98,450	9.73	(a)	29,707	(a)		(a)
11	Texas	21,646	325,074	15.02		18,408	(a)		(a)
30	Utah	19,220	250,263	13.02		7,758	(a)		(a)
45	Vermont					(a)			
18	Virginia	20,813	294,348	14.14	(a)	5,276	(a)		
10	Washington	5,570	124,952	22.43		34,128	817,086	198,358	114,501
23	West Virginia	(a)	(a)	10.00		2,330	(a)		(a)
26	Wisconsin	2,400	29,900	12.46	(a)	64,391			
47	Wyoming								
	Other States[b]	19,964	304,145	15.23	27,622	55,065	2,728,677	839,166	303,063
	Total	697,857	8,590,057	12.31	[c]1,011,730	10,389,822	11,428,696	6,976,771	5,110,597
	Per cent of brick and tile products		6.30		.74	7.62	8.38	5.12	3.75
	Per cent of total of clay products		5.05		.60	6.11	6.72	4.10	3.01

[a] Included in "Other States."
[b] Includes all products made by less than 3 producers in 1 State.
[c] Includes enameled brick, valued at $832,225, made in the following States: California, Illinois, Maryland, Missouri, New Jersey, and Pennsylvania.

Brick and tile products in the United States in 1910—Continued.

Rank.	State.	Tile, not drain.	Stove lining.	Fire brick.			Miscellaneous.[a]	Total value.	Percentage of total value.
		Value.	Value.	Quantity.	Value.	Average price per thousand.	Value.		
				Thousands.					
19	Alabama			10,365	$163,672	$15.79	$22,269	$1,645,313	1.21
44	Arizona							126,777	.09
35	Arkansas			(b)	(b)	12.42		550,105	.40
9	California	$97,685	(b)	15,416	371,017	24.07	90,754	4,744,968	3.48
16	Colorado	(b)		9,280	205,550	22.15	95,639	1,982,827	1.45
21	Connecticut and Rhode Island		(b)	(b)	(b)	22.00		1,568,486	1.15
42	Delaware							216,555	.16
39	District of Columbia							242,861	.18
40	Florida			(b)	(b)	15.00		237,268	.17
13	Georgia	51,800		3,482	67,622	19.42	10,490	2,510,740	1.84
38	Idaho and Nevada			(b)	(b)	21.82		347,437	.26
3	Illinois	(b)		20,179	368,730	18.27	44,730	14,331,414	10.51
6	Indiana	622,726	(b)	10,182	166,217	16.32	540,151	7,143,306	5.24
8	Iowa			(b)	(b)	18.00	27,185	5,310,706	3.90
12	Kansas	(b)					81,046	2,661,527	1.95
14	Kentucky	318,966		56,041	955,557	17.05	2,000	2,418,116	1.77
36	Louisiana						27,479	546,873	.40
33	Maine			(b)	(b)	25.00		599,881	.44
20	Maryland		$23,067	15,559	296,541	19.06		1,614,348	1.18
22	Massachusetts	(b)	166,018	1,999	71,780	35.91		1,469,018	1.08
15	Michigan	(b)	(b)				(b)	2,083,525	1.53
17	Minnesota			(b)	(b)	15.11		1,901,296	1.39
32	Mississippi						(b)	613,009	.45
7	Missouri	(b)	(b)	91,444	2,059,845	22.53	214,447	7,058,705	5.18
37	Montana	(b)		2,121	43,671	20.59		411,824	.30
27	Nebraska						(b)	938,827	.69
34	New Hampshire							566,121	.42
5	New Jersey	1,199,113	(b)	42,394	1,001,063	23.61	294,135	9,245,854	6.78
43	New Mexico	(b)		533	12,183	22.86		129,275	.10
4	New York	72,815	86,248	14,190	514,990	36.29	5,160	9,778,288	7.17
24	North Carolina						1,000	1,208,674	.89
41	North Dakota			(b)	(b)	30.19		227,455	.17
2	Ohio	1,896,572	(b)	116,784	1,709,039	14.63	587,909	17,231,236	12.64
28	Oklahoma						8,082	920,921	.68
29	Oregon	(b)		(b)	(b)	30.00		876,632	.64
1	Pennsylvania	413,047	132,567	346,423	6,454,928	18.63	563,563	19,814,355	14.53
48	Porto Rico	(b)						27,773	.02
31	South Carolina			(b)	(b)	13.96		696,600	.51
46	South Dakota							71,200	.05
25	Tennessee			1,287	14,907	11.58		1,205,108	.88
11	Texas			5,751	75,950	13.21	31,037	2,744,845	2.01
30	Utah			(b)	(b)	30.12	3,756	864,258	.63
45	Vermont		(b)					89,253	.07
18	Virginia			(b)	(b)	14.48		1,793,270	1.32
10	Washington			672	25,017	37.23	25,318	3,023,854	2.22
23	West Virginia	104,633		2,184	32,003	14.65		1,322,457	.97
26	Wisconsin						2,000	1,167,918	.86
47	Wyoming							50,237	.04
	Other States[c]	463,287	95,906	10,144	212,164	20.92	65,332	(d)	
	Total	5,240,644	503,806	[e]922,209	[e]18,111,474	19.09	2,743,482	136,331,296	100.00
	Per cent of brick and tile products	3.85	.37		13.28		2.01	100.00	
	Per cent of total of clay products	3.08	.30		10.64		1.61	80.15	

[a] Including adobes, aquarium ornaments, burnt-clay ballast, charcoal furnaces, chimney pipe and tops, conduits, crucibles, curbing, flue lining, gas logs, glasshouse supplies, glazed brick, grave markers, muffles, radial chimney brick, retorts, saggers, scorifiers, stone pumps, vases and ornaments, and wall coping.

[b] Included in "Other States."

[c] Includes all products made by less than 3 producers in 1 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] In the total quantity and total value of fire brick are included, respectively, 145,779,000 silica brick, valued at $3,289,028, of which 112,033,000, valued at $2,231,063, was produced, by Pennsylvania, and the remainder, 33,746,000, valued at $1,057,965, by Alabama, Colorado, Georgia, Illinois, Indiana, Missouri, and Montana.

Common brick, as its name implies, is the most widely spread of all clay products, being reported from every State and Territory, except Alaska and Hawaii. There were 9,221,517,000 common brick, valued at $55,219,551, reported in 1910, a decrease of 570,353,000 brick, or 5.82 per cent. In 1909 common brick showed an increase in quantity of 25.36 per cent over 1908. The value showed a loss in 1910 of $2,031,564, or 3.55 per cent. Only 13 States showed gain in quantity of production and 35 showed loss; 18 showed gain in value and 30 showed loss. Eleven States and Territories showed increase in both quantity and value, viz, Arizona, Colorado, District of Columbia, Georgia, Louisiana, Maryland, Michigan, Minnesota, New Hampshire, West Virginia, and Wisconsin. West Virginia showed the largest proportionate gain in quantity and value—44.33 per cent in quantity and 55.41 in value. California and South Dakota showed gain in quantity and loss in value. On the other hand, Arkansas, Connecticut, Rhode Island, Illinois, Iowa, Kentucky, Ohio, and Utah showed loss in quantity and gain in value, which means that higher prices prevailed in these latter-named States than in 1909. In 1910 common brick composed 40.51 per cent of the value of all brick and tile products and nearly one-third of all clay products. New York was the largest producer of common brick, reporting 1,380,084,000, valued at $6,897,438, or $5 per thousand, for 1910, a decrease from 1909 of 162,468,000 brick, or 10.53 per cent, and of $863,308, or 11.12 per cent. Illinois was second in 1910, reporting 1,196,526,000 brick, valued at $6,896,836; this was a loss of 60,499,000 brick, or 4.81 per cent in quantity, and a gain of $969,782, or 16.36 per cent in value. The average price per thousand in this State increased from $4.72 in 1909 to $5.76 in 1910. This increase in the price of common brick was one of the most noteworthy features of the industry in 1910. The third State in rank was Pennsylvania, which reported 828,703,000 brick, valued at $5,371,707, or $6.48 per thousand, a decrease of 43,955,000 brick, or 5.04 per cent, and of $235,783, or 4.20 per cent. Ohio ranked fourth reporting 409,773,000 brick, valued at $2,507,742, a loss of 11,226,000 brick, or 2.67 per cent, and a gain of $77,863, or 3.20 per cent. The average price per thousand in Ohio increased from $5.77 in 1909 to $6.12 in 1910. Of New York's product 1,083,684,000 brick, or 78.52 per cent, was from the Hudson River region, and of the Illinois output 764,262,000 brick, or 63.87 per cent, was from Cook County. The average price per thousand in 1910 ranged from $4.22 in Kansas to $10.34 in Wyoming, with a general average of $5.99 for the entire country. In 1909 these same States reported the extremes in price of $4.55 and $10.12, respectively. In New York there was a decrease in 1910 of 3 cents per thousand, and in Illinois and Pennsylvania an increase of $1.04 and of 5 cents per thousand, respectively.

Vitrified paving brick in 1910 was reported from 28 States, a decrease of 1. Ohio was the leading producer, reporting 289,817,000 for 1910, valued at $2,876,157, or $9.92 per thousand. This was a decrease of 34,713,000 brick, or 10.70 per cent, in quantity and of $236,971, or 7.61 per cent, in value. Ohio reported 29.94 per cent of the total quantity and 26.14 per cent of the total value in 1910. Kansas, which was fourth in quantity in 1909 was second in 1910, passing Illinois and Pennsylvania, and increasing in production 15,686,000 brick, or 15.19 per cent; it was fourth in value, with an increase of $157,559, or 16.90 per cent. Illinois was second in value though third in quantity. The average price per thousand ranged in the important producing States from $9.16 in Kansas to $16.41 in California.

Pennsylvania was the leading State in the production of front brick in 1910, as in 1909, reporting 24.56 per cent of the total quantity and 23.31 per cent of the total value. Ohio was second in both quantity and value, and New Jersey was third. Next to common brick, front brick is the most widely distributed of clay products, being reported from 42 States in 1910.

Drain tile was reported from 38 States in 1910, the only States not reporting being Arizona, Connecticut, Rhode Island, Massachusetts, New Hampshire, New Mexico, North Dakota, Oklahoma, Porto Rico, South Dakota, and Wyoming. Iowa, Indiana, Ohio, and Illinois are the leading States in the order named. These four States, together with Michigan, reported drain tile valued at $9,241,141, or 88.94 per cent of the total in 1910; in 1909 these States reported drain tile valued at $8,859,438, or 90.41 per cent of the total. Iowa showed a gain of $506,941, or 17.91 per cent in 1910; Indiana gained $53,163, or 2.63 per cent; Illinois remained practically the same as in 1909, there being a gain of only $105; Ohio and Michigan showed losses.

Sewer pipe was reported from 27 States in 1910, the same as in 1909. Ohio was the leading State and reported a product valued at $3,289,537, or 28.78 per cent of the whole. Missouri was second, California third, and Washington fourth. It is quite remarkable that of the first four States in the production of sewer pipe two should be on the Pacific coast.

Architectural terra cotta was reported from 11 States for 1910, 4 less than for 1909. In only 6 States were there a sufficient number of producers to allow publication of figures without disclosing individual returns. Of these 6 New Jersey was the leader, reporting 28.67 per cent of the total, and Illinois was second. In 1909 Illinois was first and New Jersey was second. New York was third in both years.

Fireproofing, including hollow building tile or block, was reported from 27 States in 1910, the same as for 1909. New Jersey continued to be the leading State, reporting 30.96 per cent of the total. Ohio was second and Illinois was third.

"Tile not drain" includes roofing, floor, wall, and art tile. In 1910 these high-grade wares were reported from 19 States, 2 more than in 1909—Montana, New Mexico, Oregon, and Porto Rico reporting products under this head, and Arizona and Minnesota dropping out. Ohio was the leading producer, reporting 36.19 per cent of the total for 1910. New Jersey was second and Indiana was third.

Fire brick in 1910, as in 1909, was second only to common brick in value. It was reported from 32 States in 1910 and from 34 in 1909, Idaho and Nevada (taken together) and Minnesota appearing as producers, and Kansas, Mississippi, New Hampshire, and Wisconsin dropping out. The quantity reported, including silica brick, which was also included in 1909, increased from 838,167,000 in 1909 to 922,209,000 in 1910, an increase of 84,042,000 brick, or 10.03 per cent.

The total value was $18,111,474 in 1910 as compared with $16,620,695 in 1909, a gain of $1,490,779, or 8.97 per cent. Pennsylvania continued to be the leading producer, reporting 44.62 per cent of the quantity and 43.55 per cent of the value; Ohio was second in quantity, but third in value; Missouri third in quantity and second in value; Kentucky fourth in quantity and fifth in value; New Jersey fifth in quantity and fourth in value; Illinois sixth in quantity and eighth in value; Maryland seventh in quantity and ninth in value; California eighth in quantity and seventh in value; and New York ninth in quantity and sixth in value. The other States are comparatively small producers. The average price per thousand ranged from $11.58 in Tennessee to $37.23 in Washington, with a general average of $19.09. Fire brick constituted 13.28 per cent of the value of all brick and tile products in 1910 and 10.64 per cent of all clay products; in 1909 these percentages were 12.29 and 9.99, respectively.

Pennsylvania was again the leading State in the value of brick and tile products, reporting wares valued at $19,814,355, or 14.53 per cent of the total, an increase over 1909 of $410,411, or 2.12 per cent. Ohio was second with 12.64 per cent of the total and an increase over 1909 of $301,351, or 1.78 per cent. Illinois continued to be third, reporting 10.51 per cent of the total and an increase over 1909 of $825,516, or 6.11 per cent. New York was fourth and New Jersey fifth in both years. New York's product decreased $491,939, or 4.79 per cent, and New Jersey's $135,104, or 1.44 per cent. Indiana, which was seventh in 1909, was sixth in 1910, displacing Missouri. Iowa, California, and Washington were eighth, ninth, and tenth, respectively, in both 1909 and 1910.

HUDSON RIVER REGION.

The Hudson River region, the territory extending along both sides of the Hudson from Cohoes to New York City, embracing 10 counties, 9 in New York and 1 in New Jersey, continues to be one of interest as the principal source of supply for common building brick for the metropolis and as the largest brick-producing region in the world. The total number of brick marketed from this region in 1910 was 1,142,284,000, as compared with 1,313,760,000 in 1909, a decrease of 171,476,000 brick, or 13.05 per cent. The 1910 product was, however, 266,305,000 brick, or 30.40 per cent, greater than that of 1908. The total value in 1910 was $5,544,600, a decrease from 1909 of $894,042, or 13.89 per cent. The average price per thousand in 1910 was $4.85, as compared with $4.90 in 1909.

The number of operators reporting in this region increased eight—from 127 in 1909 to 135 in 1910, the entire gain being in New York.

New York's portion was 94.87 per cent of the quantity and 94.28 per cent of the value of the output of the region. This portion, consisting of 1,083,684,000 brick, showed a decrease of 162,990,000 brick, or 13.07 per cent, from 1909, constituted 78.52 per cent of New York's output of common brick, and was greater than the output of any other State except Illinois. The value of New York's portion of the product of this region was $5,227,193, a decrease of $832,838, or 13.74 per cent. This value was greater than that of common brick in any other State except Illinois and Pennsylvania, and was exceeded by the total value of all clay products in only eight States. The value of the common brick of New York's portion of this region was 44.03 per cent of all of New York's clay products, and 53.46 per cent of its brick and title products.

Of the counties included in this region in 1910, Ulster was the first in output and value, reporting 273,770,000 brick, valued at $1,303,127; Rockland was second with 244,628,000 brick, valued at $1,164,480; and Orange was third with 160.228,000 brick, valued at $771,831. The highest average price per thousand in 1910 was in Rensselaer County, $5.19; it was $5.36 in 1909, and $5.55 in 1908. The lowest average price in 1910 was in Greene County, $4.22; and in Columbia County in 1909—$4.31. Rockland County had the largest number of firms reporting—29, a decrease of 1 from 1909.

The average price per thousand for the whole region in 1910 was $4.85, as compared with $4.90 in 1909, and with $4.69 in 1908. 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 the production of this region is small, being 58,600,000 brick in 1910, or only 5.13 per cent of the output, and $317,407, or 5.72 per cent, of the value. There was a decrease of 8,486,000 brick, or 12.65 per cent, from 1909, and of $61,204, or 16.17 per cent, in value. The average price per thousand decreased from $5.64 in 1909 to $5.42 in 1910. This was 60 cents higher than in New York's portion of the region and 23 cents higher than that of Rensselaer County, the highest average price received in any county in this region in New York.

Production of common brick in the Hudson River district from Cohoes to New York City in 1909 and 1910, by counties.

County.	1909				1910			
	Number of firms reporting.	Common brick.		Average price per thousand.	Number of firms reporting.	Common brick.		Average price per thousand.
		Quantity.	Value.			Quantity.	Value.	
		Thousands.				*Thousands.*		
Albany	11	79.250	$385,787	$4.87	14	72,699	$374,094	$5.15
Columbia	4	90,644	390,885	4.31	7	83.881	418,355	4.99
Dutchess	19	171,898	779,080	4.53	18	135,747	640,353	4.72
Greene	5	42,257	204,101	4.83	6	29,498	124,623	4.22
Orange	9	167,307	799,172	4.78	9	160,228	771,831	4.82
Rensselaer	7	22,126	118,567	5.36	9	18,301	94,915	5.19
Rockland	30	289,479	1,499,678	5.18	29	244,628	1,164,480	4.76
Ulster	24	304,737	1,466,194	4.81	24	273,770	1,303,127	4.76
Westchester	8	78,976	416,567	5.27	9	64,932	335,415	5.17
Total for New York	117	1,246,674	6,060,031	4.86	125	1,083,684	5,227,193	4.82
Bergen County, N. J.	10	67,086	378,611	5.64	10	58,600	317,407	5.42
Grand total	127	1,313,760	6,438,642	4.90	135	1,142,284	5,544,600	4.85

POTTERY.

INTRODUCTION.

The following tables show the status of the pottery industry in 1909 and 1910. The figures show that the industry on the whole was in a highly satisfactory condition, every item of the classification except one showing an increase and every product except one showing its maximum value. Judged from the value of the product, 1910 was the most prosperous year in the history of the industry, as the value of pottery products in that year was the largest ever recorded in the United States—$2,343,794, or 7.45 per cent, greater than the largest previous value, that for 1906. The imports increased 4.90 per cent in 1910, but on the other hand they were nearly two and a half million dollars, or 18 per cent, less than their maximum, which was in 1907. The proportion of domestic production to consumption, 77.08 per cent, also was the highest ever recorded.

A study of the statistics of the value of pottery produced in the United States reveals an almost unbroken increase in the volume of business as measured by value of product. With the constant improvement in the American product, the steady growth of the industry is the natural outcome.

The earnest efforts of the American potters have been to make their wares equal or superior to the imported ware. How well they have succeeded is best shown by the growth of the pottery industry. In 1899 the value of the pottery products of the United States was $17,250,250 and of the imports $7,906,940; in 1910 the production was $33,784,678 and the imports were $11,127,405—an increase of 95.85 per cent in production and 40.73 per cent in imports. If only white ware, including sanitary ware and porcelain electrical supplies, be considered, the increase in domestic production is more striking. These wares were valued in 1899 at $11,869,349; in 1910 at $27,296,255, an increase of 129.97 per cent; imports of these wares were valued in 1899 at $7,866,776 and in 1910 at $10,976,544, an increase of but 39.53 per cent.

PRODUCTION.

The following table shows the statistics of the pottery production of the United States from 1901 to 1910:

Value of pottery products in the United States, 1901–1910, 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.
1901......	535	$703,698	$2,855,638	$11,608,898	$1,392,864	$2,877,650	$1,141,362	$1,883,750	$22,463,860
1902......	518	735,386	3,383,678	12,371,111	1,219,293	3,555,662	1,350,255	1,512,068	24,127,453
1903......	546	698,175	3,658,836	12,493,012	1,757,502	3,362,263	1,464,980	2,001,284	25,436,052
1904......	556	756,625	3,701,844	11,924,404	1,512,115	3,585,375	1,431,452	2,246,455	25,158,270
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
1910......	463	854,196	3,796,688	14,780,980	1,962,126	6,758,996	3,794,153	1,837,539	33,784,678

[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 1910 was $33,784,678, an increase over 1909 of $2,735,237, or 8.81 per cent. This is the largest value reported and exceeds the value reported for 1906, the year of maximum value until 1910, by $2,343,794, or 7.45 per cent. Only one item decreased in 1910, stoneware and yellow and Rockingham ware, which showed a loss of $197,171, or 4.94 per cent. Every other product showed its maximum value.

The product showing the largest gain was, as in 1909, white ware, which increased in value $1,052,664, or 7.67 per cent, and the largest proportionate gain was shown by porcelain electrical supplies, $746,654, or 24.50 per cent.

The value of the white ware, including china, but exclusive of sanitary ware and porcelain electrical supplies, was $16,743,106, as compared with $15,495,082 in 1909, a gain of $1,248,024, or 8.05 per cent. The value of these products in 1910 was $802,827, or 5.04 per cent greater than that of 1906, the year of maximum value prior to 1910. These products constituted 49.56 per cent of the value of all pottery products in 1910 and 49.90 per cent in 1909. If the value of sanitary ware and porcelain electrical supplies is added, the value for 1910 would be $27,296,255, or 80.79 per cent of all pottery products; this would be a gain of $2,764,379, or 11.27 per cent, over 1909, and an increase of $7,858,493 over 1908.

Chinaware, though comparatively small in production, the highest grade of general ware, and the most interesting technically, showed a gain of $195,360, or 11.06 per cent, in 1910.

Sanitary ware, which consists of lavatories, bathtubs, etc., made a gain of $769,701, or 12.85 per cent.

In the following tables will be found the statistics of the production of pottery in the United States in 1909 and 1910, by States and varieties of product, the former year being given for comparison:

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	[d] 466	805,906	3,993,859	13,728,316	[b] 1,766,766
	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 3 producers in 1 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	d1,123,284	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 3 producers in 1 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.

Value of pottery products in 1910 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, semi-porcelain ware, and semivitreous porcelain ware.	China bone, China delft, and belleek ware.
19	Alabama	16	$3,475	$16,371		
18	Arkansas	4	(a)	26,150		
14	California	11	34,367	42,726		
15	Colorado	4	(a)	(a)		
	Connecticut		(a)	(a)		
	District of Columbia		(a)			
20	Georgia	21	10,558	10,740		
7	Illinois	22	25,658	708,958		
6	Indiana	14	12,650	89,423	(a)	
22	Iowa	5	6,290	(a)		
	Kansas		(a)			
11	Kentucky	8	10,004	139,417		
	Louisiana		(a)			
	Maine			(a)		
9	Maryland	9	9,171		(a)	
8	Massachusetts	13	148,909	9,654	(a)	
13	Michigan	6	90,450			
	Minnesota		(a)	(a)		
21	Mississippi	6	(a)	19,027		
17	Missouri	8	3,080	25,981		
	Montana		(a)			
	New Hampshire					
2	New Jersey	58	26,529	55,734	$1,345,156	$1,131,412
	New Mexico					
5	New York	22	26,863	43,325	(a)	642,592
23	North Carolina	22	1,961	13,029		
1	Ohio	113	161,799	1,664,572	9,730,408	
	Oregon		(a)	(a)		
4	Pennsylvania	33	178,348	323,990	(a)	188,122
	Porto Rico		(a)	(a)		
25	South Carolina	4	5,540	(a)		
10	Tennessee	9	4,540	44,640		
12	Texas	13	6,481	112,604		
	Utah		(a)	(a)		
16	Virginia	3				
	Washington		(a)	(a)		
3	West Virginia	14		(a)	1,894,429	
24	Wisconsin	3	8,965			
	Other States [b]		78,558	450,347	1,810,987	
	Total	[c] 463	854,196	3,796,688	14,780,980	1,962,126
	Per cent of pottery products		2.53	11.24	43.75	5.81
	Per cent of total clay products		.50	2.23	8.69	1.15
	Number of firms reporting each variety		159	180	63	14

[a] Included in "Other States."
[b] Includes all products made by less than 3 producers in 1 State.
[c] Includes 22 firms not distributed.

Value of pottery products in 1910 by varieties of products, by States—Continued.

Rank of State.	State.	Sanitary ware.	Porcelain electrical supplies.	Miscellaneous.[a]	Total value.	Percentage of total.
19	Alabama			$2,400	$22,246	0.07
18	Arkansas			2,000	28,350	.08
14	California	(b)		(b)	97,423	.29
15	Colorado			8,387	50,887	.15
	Connecticut		(b)	(b)	(c)	
	District of Columbia				(c)	
20	Georgia				21,298	.06
7	Illinois	(b)		(b)	844,747	2.50
6	Indiana	$468,301	(b)		956,704	2.83
22	Iowa			(b)	17,535	.05
	Kansas				(c)	
11	Kentucky				149,421	.44
	Louisiana			(b)	(c)	
	Maine				(c)	
9	Maryland	(b)		4,000	233,925	.69
8	Massachusetts		(b)	22,423	238,395	.71
13	Michigan		(b)	(b)	112,697	.33
	Minnesota				(c)	
21	Mississippi				19,990	.06
17	Missouri				29,061	.09
	Montana				(c)	
	New Hampshire			(b)	(c)	
2	New Jersey	4,955,066	$874,013	200,545	8,588,455	25.42
	New Mexico			(b)	(c)	
5	New York	(b)	957,101	67,687	2,093,661	6.20
23	North Carolina				14,990	.05
1	Ohio	327,438	1,277,144	1,133,351	14,294,712	42.31
	Oregon				(c)	
4	Pennsylvania	254,747	(b)	14,726	2,279,930	6.75
	Porto Rico			(b)	(c)	
25	South Carolina				7,990	.02
10	Tennessee			(b)	209,180	.62
12	Texas				119,085	.35
	Utah				(c)	
16	Virginia		(b)	(b)	46,417	.14
	Washington				(c)	
3	West Virginia	618,868	(b)	97,343	2,675,588	7.92
24	Wisconsin				8,965	.03
	Other States[d]	134,576	685,895	284,677	[e]623,026	1.84
	Total	6,758,996	3,794,153	1,837,539	33,784,678	100.00
	Per cent of pottery products	20.00	11.23	5.44	100.00	
	Per cent of total clay products	3.97	2.23	1.08	19.85	
	Number of firms reporting each variety	38	37	73		

[a] Including art and chemical pottery, craquelle porcelain, faïence, Grueby, Hampshire, Indian, Pewabic, and Teco pottery, Guernsey earthenware, handmade tile jardinieres, pins, stilts and spurs for potters' use, porcelain door knobs, filter stones and tubes, shuttle eyes and thread guides, porcelain hardware trimmings, porcelain lighting appliances, tobacco pipes, toy marbles, turpentine cups, and vases.

[b] Included in "Other States."

[c] Included in [e] ($623,026).

[d] Includes all products made by less than 3 producers in 1 State.

[e] Made up of State totals of Connecticut, District of Columbia, Kansas, Louisiana, Maine, Minnesota, Montana, New Hampshire, New Mexico, Oregon, Porto Rico, Utah, and Washington.

The number of States reporting in 1910 ware classed as pottery in this report was 38. As in former years, the important producing States are few. General ware was reported from 8, a decrease of 1—Illinois, which reported this ware in 1909, reported none in 1910; china from 3; sanitary ware from 9; porcelain electrical supplies from 10, an increase of 2—Michigan and West Virginia.

Red earthenware was reported from 33 States, an increase of 4—Arkansas, Kansas, Louisiana, and Mississippi. Pennsylvania was the leading State, as in 1909, reporting ware of this variety valued at $178,348, an increase of $18,552, or 11.61 per cent, as compared with 1909. Ohio, which was third in 1909, was second in 1910, reporting ware valued at $161,799, a gain of $16,662, or 11.48 per cent. Massachusetts, which was second in 1909, was third in 1910, reporting ware valued at $148,909, a loss of $5,978, or 3.86 per cent. These 3 leading States reported 57.25 per cent of the total in 1910. Red earthenware was reported by 159 producers in 1910, 147 in 1909, and 179 in 1908. In 1910 it constituted 2.53 per cent of the total of pottery products and in 1909 2.60 per cent.

Stoneware, including yellow and Rockingham ware, was reported from 29 States in 1909 and from 28 in 1910. Kansas, Maryland, and Wisconsin reported no product in 1910, and Porto Rico and Utah appeared as producers. Ohio, as for many years, was the leading State, though it showed a loss in 1910, as compared with 1909, of $142,226, or 7.87 per cent. Illinois was again second, showing a small increase, $6,547—less than 1 per cent. Pennsylvania was third, reporting ware valued at $323,990, a gain over 1909 of $26,961, or 9.08 per cent. These 3 States reported 71.05 per cent of the value of all stoneware and Rockingham ware in 1910, Ohio alone reporting 43.84 per cent of the total. The number of producers reporting this ware continued to decrease, 180 reporting in 1910 as compared with 196 in 1909 and with 209 in 1908. It constituted 11.24 per cent of all pottery products in 1910, 12.86 per cent in 1909, and 14 per cent in 1908.

As shown by the tables, the pottery products of greatest value are embraced under the heading white ware, though they are reported from but 8 States, a decrease of 1—Illinois. The wares embraced under this head represent the general household and compose the larger portion of what is known as pottery. Ohio has been for many years the leading producer, reporting for 1910 white ware valued at $9,730,408, an increase of $846,219, or 9.52 per cent. This was 65.83 per cent of the value of the entire product. For 1909 Ohio reported 64.71 per cent of this product and for 1908 $7,228,636, or 63 per cent. West Virginia has been second as a producer for several years, reporting ware valued at $1,894,429 for 1910, an increase of $124,621, or 7.04 per cent. New Jersey was third in both years, reporting wares valued at $1,345,156 and $1,242,361 in 1910 and 1909, respectively; this was a gain in 1910 of $102,795, or 8.27 per cent, over 1909. White ware composed 43.75 per cent of all pottery products in 1910, 44.21 in 1909, and 45.65 in 1908. The number of producers of white ware reporting increased by 1 in 1910.

China, which was reported from 4 States in 1909, was reported from but 3 in 1910, Ohio reporting none for 1910. New Jersey was the leading china-producing State, and reported ware valued at $1,131,412 in 1910, as compared with $1,082,398 in 1909, a gain of $49,014, or 4.53 per cent; but it did not quite reach the maximum value reported in 1907, which was $1,135,885. The output of New Jersey constituted 57.66 per cent of the entire product in 1910. New York was second and Pennsylvania was third. China constitutes but a small proportion of the value of the pottery products, furnishing but 5.81 per cent of the total in 1910 and 5.69 per cent in 1909. It was reported by 14 producers in 1910, the same as in 1909.

Nine States reported sanitary ware for 1910, the same as for 1909. New Jersey continued to be by far the largest producer, reporting ware valued at $4,955,066, or 73.31 per cent of the total for 1910. This was an increase of $614,026, or 14.14 per cent, over 1909. West

Virginia was second, reporting wares valued at $618,868, an increase of $118,436, or 23.67 per cent over 1909; and Indiana was third. The number of producers increased 3 in 1910. Sanitary ware was 20 per cent of the value of the total pottery products in 1910 and 19.29 per cent in 1909.

Porcelain electrical supplies were reported from 10 States, an increase of 2—Michigan and West Virginia. In only 3, however, was the number of producers requisite to permit publication of figures. Ohio was the largest producer, reporting $1,277,144, or 33.66 per cent of the whole, a gain of $130,450, or 11.38 per cent, over 1909. Notwithstanding the large increase in this industry, the number of firms reporting these wares decreased by 3. It composed 11.23 per cent of the total value of pottery products in 1910 and 9.82 per cent in 1909.

As for many years, Ohio continued to be the leading pottery-producing State of the Union, reporting for 1910 wares valued at $14,294,712, or 42.31 per cent of the total. This was an increase of $878,356, or 6.55 per cent, over 1909, when Ohio reported pottery valued at $13,416,356, or 43.21 per cent of the total. Ohio's principal pottery product is white ware, which composed 68.07 per cent of its entire product in 1910. New Jersey was second in 1910, with wares valued at $8,588,455, or 25.42 per cent of the total. This was an increase of $797,319, or 10.23 per cent. New Jersey's principal pottery product is sanitary ware, which composed 57.69 per cent of its total in 1910. West Virginia was third, reporting ware valued at $2,675,588, or 7.92 per cent of the total, which was a gain of $325,118, or 13.83 per cent. Pennsylvania was fourth, displacing New York, the former reporting 6.75 per cent and the latter 6.20 per cent of the total. Indiana and Illinois maintained their relative ranks of sixth and seventh, with 2.83 per cent and 2.50 per cent of the total, respectively. The first five States—Ohio, New Jersey, West Virginia, Pennsylvania, and New York—reported 88.60 per cent of the total; in 1909 these States reported 87.69 per cent of the total.

CONSUMPTION.

The pottery imported into the United States in 1910 was valued at $11,127,405 and the production at $33,784,678, a total of $44,912,083. After deducting exports, domestic $1,041,689 and foreign $41,048, the net consumption was valued at $43,829,346, of which the domestic production was 77.08 per cent. In 1909 the proportion was 76.19 per cent, and the next highest was in 1902, when it was 72.91.

IMPORTS AND EXPORTS.

The following table shows the imports of clay products from 1901 to 1910:

Value of earthenware, china, brick, and tile imported and entered for consumption in the United States, 1901–1910.

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.		
1901	$51,551	$1,094,078	$8,385,514	$9,531,143	$150,268	$9,681,411
1902	58,926	1,016,010	8,495,598	9,570,534	235,737	9,806,271
1903	95,890	1,234,223	9,897,588	11,227,701	228,589	11,456,290
1904	81,951	1,329,146	9,859,144	11,270,241	218,170	11,488,411
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
1910	150,861	1,293,986	9,682,558	11,127,405	206,613	11,334,018

[a] Including Rockingham ware.

The imports of all clay products in 1910 increased $537,270, or 4.98 per cent; in 1909 there was an increase over 1908 of 1.04 per cent. Of these imports 98.18 per cent was pottery and 1.82 per cent brick and tile. Of the pottery imports 98.64 per cent was general ware and 1.36 per cent was of the lower grades. The pottery imports increased $520,193, or 4.90 per cent, in 1910 and the brick imports $17,077, or 9.01 per cent.

Value of exports of clay wares of domestic manufacture from the United States, 1905–1910.

Year.	Brick.			Pottery.			Grand total.
	Fire.	All other.	Total.	Earthen and stone ware.	China.	Total.	
1905	$536,002	[a]$263,876	$799,878	$882,069	$101,485	$983,554	$1,783,432
1906	637,441	[a] 247,625	885,066	1,003,969	114,481	1,118,450	2,003,516
1907	631,779	[a] 185,192	816,971	1,022,730	108,911	1,131,641	1,948,612
1908	[b] 550,243	113,243	663,486	906,266	77,494	983,760	1,647,246
1909	[b] 1,002,270	147,622	1,149,892	776,842	86,853	863,695	2,013,587
1910	[c] 634,775	968,138	1,602,913	928,475	113,214	1,041,689	2,644,602

[a] Building brick only.
[b] Includes all brick other than building brick.
[c] Figures cover period from July 1 to Dec. 31.

The exports of domestic clay products increased in value $631,015, or 31.34 per cent, in 1910; in 1909 they increased $366,341, or 22.24 per cent. Of these exports 39.39 per cent was brick and 60.61 per cent pottery. Brick and tile exports gained $453,021, or 39.40 per cent, in 1910. Pottery exports increased $177,994, or 20.61 per cent; of these, china constituted 10.87 per cent and the lower grades 89.13 per cent.

CLAY PRODUCTS IN VARIOUS STATES.

The following table gives the statistics of clay products from 1906 to 1910, 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 1906 to 1910.

ALABAMA.

Product.	1906	1907	1908	1909	1910
Brick:					
Common—					
Quantity	166,225,000	159,315,000	120,237,000	146,180,000	135,785,000
Value	$1,046,986	$1,004,644	$690,963	$799,693	$746,961
Average per M	$6.30	$6.31	$5.75	$5.47	$5.50
Vitrified—					
Quantity	(a)	13,362,000	18,248,000	20,444,000	19,772,000
Value	(a)	$183,895	$244,084	$262,376	$236,516
Average per M	$11.62	$13.76	$13.38	$12.83	$11.96
Front—					
Quantity	(a)	(a)	(a)	(a)	(a)
Value	(a)	(a)	(a)	(a)	(a)
Average per M	$11.35	$13.90	$17.89	$16.19	$15.96
Fancy ... value	....	(a)	(a)	(a)	....
Fire ... do	$157,147	$170,711	$122,354	$196,887	$163,672
Draintile ... do	$2,285	(a)	$2,046	(a)	$3,773
Sewer pipe ... do	(a)	(a)	(a)	(a)	(a)
Fireproofing ... do	(a)	(a)	(a)	(a)	(a)
Pottery:					
Red earthenware ... do	$2,620	$7,530	$15,058	$11,886	$3,475
Stoneware and yellow and Rockingham ware .. value	$35,376	$20,215	$9,031	$24,453	$16,371
Miscellaneous value	$444,485	$367,414	$476,070	$404,832	$496,791
Total value	$1,688,899	$1,754,409	$1,559,606	$1,700,127	$1,667,559
Number of operating firms reporting	112	100	103	100	87
Rank of State	21	20	19	22	22

a Included in "Miscellaneous."

Clay products of the United States, by States, from 1906 to 1910—Continued.

CALIFORNIA.

Product.	1906	1907	1908	1909	1910
Brick:					
Common—					
Quantity	278,780,000	339,439,000	236,383,000	276,396,000	280,265,000
Value	$1,962,866	$2,483,062	$1,593,814	$1,749,209	$1,694,312
Average per M	$7.05	$7.32	$6.74	$6.33	$6.05
Vitrified—					
Quantity	(a)	(a)	3,499,000	7,180,000	8,538,000
Value	(a)	(a)	$66,214	$135,203	$140,130
Average per M	$18.49	$15.79	$18.92	$18.83	$16.41
Front—					
Quantity	18,421,000	12,922,000	12,393,000	10,359,000	11,475,000
Value	$501,746	$283,375	$283,701	$309,770	$285,468
Average per M	$27.24	$21.93	$22.89	$29.90	$24.88
Fancy or ornamental.value	(a)	$150,165	$34,947	(a)	$48,572
Enameled.....do	(a)	(a)	(a)	$57,914	$100,531
Fire.....do	$347,806	$374,378	$325,760	$297,577	$371,017
Stove lining.....do	(a)	(a)	(a)	(a)	(a)
Draintile.....do	$30,545	$53,997	$34,457	$29,620	$55,386
Sewer pipe.....do	$827,477	$1,086,916	$1,036,320	$904,473	$1,031,061
Architectural terra cotta.....do	$254,932	$528,623	$500,130	$345,402	$678,249
Fireproofing.....do	$130,568	$208,205	$188,221	$128,447	$151,503
Tile, not drain.....do	$69,023	$107,492	$84,484	$130,941	$97,685
Pottery:					
Red earthenware.....do	$37,781	$42,856	$42,962	$42,464	$34,367
Stoneware and yellow and Rockingham ware..value	$25,199	$39,382	$29,300	$59,907	$42,726
Sanitary ware.....do	(a)	(a)	(a)	(a)	(a)
Miscellaneous.....do	$176,287	$382,086	$303,435	$246,238	$111,384
Total value	$4,364,230	$5,740,537	$4,523,745	$4,437,165	$4,842,391
Number of operating firms reporting	113	118	119	99	107
Rank of State	8	8	8	9	9

COLORADO.

Product.	1906	1907	1908	1909	1910
Brick:					
Common—					
Quantity	120,944,000	118,551,000	112,859,000	121,908,000	128,711,000
Value	$787,084	$803,701	$795,733	$801,833	$852,986
Average per M	$6.51	$6.78	$7.05	$6.58	$6.63
Vitrified—					
Quantity	6,239,000	3,145,000	2,372,000	(a)	(a)
Value	$74,460	$37,782	$30,262	(a)	(a)
Average per M	$11.93	$12.01	$12.76	$14.12	$14.15
Front—					
Quantity	24,147,000	24,572,000	31,667,000	38,782,000	30,334,000
Value	$256,770	$254,522	$364,367	$473,039	$368,538
Average per M	$10.63	$10.36	$11.51	$12.20	$12.15
Fancy.....value	$2,806	$46,128	$34,777	....	(a)
Enameled.....do	(a)	(a)	....	....	....
Fire.....do	$278,407	$430,897	$206,161	$265,089	$205,550
Draintile.....do	$6,126	$19,608	$16,472	$13,626	$18,066
Sewer pipe.....do	(a)	(a)	(a)	(a)	(a)
Architectural terra cotta.....do	(a)	(a)	(a)	....	....
Fireproofing.....do	(a)	(a)	(a)	(a)	$32,565
Tile, not drain.....do	$40,640	(a)	(a)	(a)	(a)
Pottery:					
Red earthenware.....do	$9,077	$1,931	$11,250	(a)	(a)
Stoneware and yellow and Rockingham ware..value	$26,266	$35,644	(a)	(a)	(a)
Miscellaneous.....do	$349,452	$411,262	$511,059	$495,437	$556,009
Total value	$1,831,088	$2,041,475	$1,970,081	$2,049,024	$2,033,714
Number of operating firms reporting	94	88	80	73	77
Rank of State	19	16	15	16	17

a Included in "Miscellaneous."

Clay products of the United States, by States, from 1906 to 1910—Continued.

CONNECTICUT AND RHODE ISLAND.

Product.	1906	1907	1908	1909	1910
Brick:					
Common—					
Quantity	212,648,000	198,414,000	131,760,000	242,000,000	240,234,000
Value	$1,503,929	$1,240,575	$749,093	$1,408,033	$1,454,471
Average per M	$7.07	$6.25	$5.69	$5.82	$6.05
Vitrified—					
Quantity	(*a*)	(*a*)	(*a*)	(*a*)	(*a*)
Value	(*a*)	(*a*)	(*a*)	(*a*)	(*a*)
Average per M	$16.36	$24.23	$16.25	$13.00	$14.62
Front—					
Quantity	(*a*)	(*a*)	(*a*)	(*a*)	(*a*)
Value	(*a*)	(*a*)	(*a*)	(*a*)	(*a*)
Average per M	$16.51	$15.44	$15.75	$14.00	$15.75
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*)	(*b*)	(*b*)
Stoneware and yellow and Rockingham ware .. value	(*a*)	(*a*)	(*a*)	(*b*)	(*b*)
Porcelain electrical supplies, value	(*a*)	(*a*)	(*a*)	(*b*)	(*b*)
Miscellaneous ... value	$243,276	$244,017	$152,468	$107,562	$114,015
Total value	$1,747,205	$1,484,592	$901,561	$1,515,595	$1,568,486
Number of operating firms reporting	42	43	41	42	42
Rank of Connecticut and Rhode Island	20	24	27	24	23

GEORGIA.

Product.	1906	1907	1908	1909	1910
Brick:					
Common—					
Quantity	303,286,000	318,844,000	248,585,000	275,809,000	305,025,000
Value	$1,783,988	$1,807,148	$1,335,349	$1,469,839	$1,620,174
Average per M	$5.88	$5.67	$5.37	$5.33	$5.31
Vitrified—					
Quantity	(*a*)	(*a*)	(*a*)	(*a*)	(*a*)
Value	(*a*)	(*a*)	(*a*)	(*a*)	(*a*)
Average per M	$13.99	$12.50	$15.50	$12.00	$11.11
Front—					
Quantity	2,094,000	1,625,000	2,929,000	7,188,000	13,649,000
Value	$20,747	$16,450	$34,385	$61,131	$129,393
Average per M	$9.91	$10.12	$11.74	$8.50	$9.48
Fancy or ornamental. value	....	(*a*)	....	(*a*)	(*a*)
Fire ... do	$51,310	$82,391	$53,466	$62,452	$67,622
Stove lining ... do	....	(*a*)	....	....	....
Draintile ... do	$12,000	$8,050	(*a*)	$4,820	$8,920
Sewer pipe ... do	$221,000	$244,000	$253,664	$351,492	$373,387
Architectural terra cotta .. do	(*a*)	(*a*)	(*a*)	(*a*)	(*a*)
Fireproofing ... do	(*a*)	(*a*)	(*a*)	(*a*)	$19,354
Tile, not drain ... do	(*a*)	(*a*)	(*a*)	(*a*)	$51,800
Pottery:					
Red earthenware ... do	$5,345	$18,440	$5,710	$12,945	$10,558
Stoneware and yellow and Rockingham ware .. value	$14,912	$15,445	$4,941	$16,435	$10,740
Miscellaneous ... do	$291,322	$298,313	$241,096	$315,387	$240,090
Total value	$2,400,624	$2,490,237	$1,928,611	$2,294,501	$2,532,038
Number of operating firms reporting	99	106	108	105	109
Rank of State	13	13	16	15	15

a Included in "Miscellaneous."

b Produced by Connecticut alone. In 1909 and 1910 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 1906 to 1910—Continued.

ILLINOIS.

Product.	1906	1907	1908	1909	1910
Brick:					
Common—					
Quantity	1,195,210,000	1,494,807,000	1,119,224,000	1,257,025,000	1,196,526,000
Value	$5,719,906	$6,499,777	$4,834,652	$5,927,054	$6,896,836
Average per M	$4.79	$4.35	$4.32	$4.72	$5.76
Vitrified—					
Quantity	122,227,000	126,927,000	138,362,000	140,105,000	115,903,000
Value	$1,306,476	$1,405,821	$1,622,496	$1,562,373	1,415,355
Average per M	$10.69	$11.08	$11.73	$11.15	$12.21
Front—					
Quantity	30,022,000	20,828,000	22,851,000	32,416,000	22,138,000
Value	$341,298	$266,270	$301,515	$385,170	$274,699
Average per M	$11.37	$12.78	$13.19	$11.88	$12.41
Fancy or ornamental.value	$11,635	(a)	(a)	$12,223	$10,875
Enameled.....do	(a)	(a)	(a)	(a)	(a)
Fire.....do	$236,032	$241,008	$250,444	$682,793	$368,730
Stove lining.....do	(a)	(a)	(a)	....	....
Draintile.....do	$1,052,588	$1,031,192	$1,421,878	$1,613,593	$1,613,698
Sewer pipe.....do	$587,805	$662,487	$514,386	$394,461	$538,633
Architectural terra cotta...do	(a)	(a)	(a)	$1,898,865	$1,680,438
Fireproofing.....do	$416,928	$429,535	$264,986	$439,796	$552,905
Tile, not drain.....do	(a)	(a)	$124,425	$335,020	(a)
Pottery:					
Red earthenware.....do	$37,543	$37,045	$24,821	$31,771	$25,658
Stoneware and yellow and Rockingham ware..value	$897,650	$898,267	$733,373	$702,411	$708,958
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)	(a)
Porcelain electrical supplies, value	(a)	(a)	....	....	....
Miscellaneous.....value	$2,026,320	$1,749,087	$1,466,138	$358,923	$1,089,376
Total value	$12,634,181	$13,220,489	$11,559,114	$14,344,453	$15,176,161
Number of operating firms reporting	466	417	400	379	346
Rank of State	5	4	4	4	4

INDIANA.

Product.	1906	1907	1908	1909	1910
Brick:					
Common—					
Quantity	307,076,000	251,766,000	224,454,000	251,227,000	234,297,000
Value	$1,778,270	$1,509,415	$1,221,910	$1,579,185	$1,402,154
Average per M	$5.79	$6.00	$5.44	$6.29	$5.98
Vitrified—					
Quantity	45,725,000	46,224,000	57,748,000	53,597,000	61,034,000
Value	$502,509	$548,448	$776,533	$559,201	$682,888
Average per M	$10.99	$11.87	$13.45	$10.44	$11.19
Front—					
Quantity	35,090,000	36,890,000	34,336,000	50,135,000	46,691,000
Value	$395,368	$437,796	$403,545	$511,171	$478,627
Average per M	$11.27	$11.87	$11.75	$10.20	$10.25
Fancy or ornamental.value	$4,700	(a)	(a)	(a)	(a)
Fire.....do	$149,351	$160,373	$115,895	$280,921	$166,217
Stove lining.....do	(a)	....	....	....	(a)
Draintile.....do	$1,373,441	$1,437,735	$1,797,329	$2,018,401	$2,071,564
Sewer pipe.....do	$486,897	$487,537	$486,946	$332,419	$406,543
Architectural terra cotta..do	(a)	(a)	(a)	(a)	(a)
Fireproofing.....do	$422,419	$414,343	$359,817	$410,500	$466,877
Tile, not drain.....do	(a)	(a)	$505,908	(a)	$622,726
Pottery:					
Red earthenware.....do	$6,550	$5,075	$7,450	$10,090	$12,650
Stoneware and yellow and Rockingham ware..value	$66,774	$45,579	$37,020	$59,598	$89,423
Whiteware, including C. C. ware, white granite, semi-porcelain ware, and semi-vitreous porcelain ware, value	(a)	(a)	(a)	(a)	(a)

a Included in "Miscellaneous."

Clay products of the United States, by States, from 1906 to 1910—Continued.

INDIANA—Continued.

Product.	1906	1907	1908	1909	1910
Pottery—Continued.					
Sanitary ware........value..	$435,000	$400,000	$350,000	(a)	$168,301
Porcelain electrical supplies, value....................	(a)	(a)	(a)	(a)	(a)
Miscellaneous............value..	$1,536,955	$1,411,823	$677,814	$1,883,707	$1,232,040
Total value..............	$7,158,234	$6,858,124	$6,740,167	$7,645,223	$8,100,010
Number of operating firms reporting....................	419	392	369	348	249
Rank of State..................	6	7	6	6	6

IOWA.

Product.	1906	1907	1908	1909	1910
Brick:					
Common—					
Quantity............	168,871,000	157,618,000	135,678,000	153,065,000	149,914,000
Value..................	$1,118,709	$1,085,383	$904,308	$1,072,340	$1,088,266
Average per M..........	$6.62	$6.89	$6.67	$7.01	$7.26
Vitrified—					
Quantity..............	16,930,000	21,686,000	16,672,000	18,586,000	19,887,000
Value..................	$185,990	$223,193	$185,112	$198,780	$239,283
Average per M..........	$10.99	$10.29	$11.10	$10.70	$12.03
Front—					
Quantity..............	8,871,000	8,028,000	7,900,000	12,015,000	8,142,000
Value..................	$101,795	$96,316	$86,232	$138,218	$103,276
Average per M..........	$11.48	$12.00	$10.92	$11.50	$12.68
Fancy or ornamental.value..	....	....	(a)	(a)	....
Fire..................do....	$930	$795	....	(a)	(a)
Draintile..................do....	$1,721,614	$2,011,793	$2,509,505	$2,830,910	$3,337,851
Sewer pipe..................do....	(a)	(a)	$211,044	$282,637	$313,430
Fireproofing, terra-cotta lumber, and hollow building block or tile............value..	$162,664	$176,854	$129,003	$304,398	$200,965
Pottery:					
Red earthenware. ....do....	$10,100	$8,250	$8,161	$8,175	$6,290
Stoneware and yellow and Rockingham ware..value..	(a)	(a)	$7,549	(a)	(a)
Miscellaneous.............do....	$167,225	$126,201	$28,583	$63,238	$38,880
Total value..............	$3,469,027	$3,728,785	$4,069,497	$4,898,696	$5,328,241
Number of operating firms reporting....................	304	276	263	247	232
Rank of State..................	9	9	9	8	8

KANSAS.

Product.	1906	1907	1908	1909	1910
Brick:					
Common—					
Quantity................	314,371,000	263,887,000	225,820,000	254,890,000	218,353,000
Value..................	$1,376,552	$1,189,263	$896,542	$1,160,877	$922,940
Average per M..........	$4.38	$4.51	$3.97	$4.55	$4.22
Vitrified—					
Quantity................	78,199,000	85,110,000	102,922,000	103,264,000	118,950,000
Value..................	$658,392	$727,979	$862,019	$932,419	$1,089,978
Average per M..........	$8.42	$8.55	$8.38	$9.03	$9.16
Front—					
Quantity................	19,875,000	24,381,000	29,477,000	26,170,000	25,814,000
Value..................	$187,577	$236,876	$233,578	$235,875	$223,875
Average per M..........	$9.44	$9.72	$7.92	$9.01	$8.67
Fancy or ornamental.value..	(a)	(a)	(a)	(a)	(a)
Fire..................do....	(a)	(a)	(a)	(a)	....
Draintile..................do....	$19,694	$15,320	$22,359	$37,862	$50,726
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)	(a)	(a)	(a)	(a)
Pottery:					
Stoneware and yellow and Rockingham ware..value..	(b)	(b)	(b)	(b)	(b)
Miscellaneous.............do....	$190,156	$200,620	$234,307	$342,789	$374,008
Total value..............	$2,432,371	$2,370,058	$2,248,805	$2,709,822	$2,661,527
Number of operating firms reporting....................	66	67	65	58	59
Rank of State..................	12	14	11	13	13

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 1906 to 1910—Continued.

KENTUCKY.

Product.	1906	1907	1908	1909	1910
Brick:					
Common—					
Quantity	142,185,000	143,731,000	110,545,000	119,183,000	115,890,000
Value	$881,879	$932,469	$687,365	$741,115	$743,732
Average per M	$6.20	$6.49	$6.22	$6.22	$6.42
Vitrified—					
Quantity	(a)	(a)	(a)	(a)	(a)
Value	(a)	(a)	(a)	(a)	(a)
Average per M	$14.13	$14.27	$13.26	$12.69	$12.74
Front—					
Quantity	11,893,000	7,926,000	11,067,000	11,626,000	10,238,000
Value	$109,771	$86,568	$119,785	$104,022	$99,532
Average per M	$9.23	$10.92	$10.82	$8.95	$9.72
Fancy ... value	....	....	....	(a)	(a)
Fire ... do	$898,527	$940,415	$770,221	$899,363	$955,557
Stove lining ... do	....	....	....	(a)	....
Draintile ... do	$27,359	$32,723	$53,308	$53,213	$66,217
Sewer pipe ... do	(a)	(a)	(a)	(a)	(a)
Architectural terra cotta ... do	....	....	....	(a)	....
Fireproofing ... do	(a)	(a)	$7,263	(a)	(a)
Tile, not drain ... do	$296,391	$255,054	$215,000	$296,179	$318,966
Pottery:					
Red earthenware ... do	$26,637	$27,546	$23,448	$20,225	$10,004
Stoneware and yellow and Rockingham ware .. value	$140,572	$139,075	$130,200	$126,172	$139,417
Miscellaneous ... do	$211,287	$197,514	$232,518	$238,583	$234,112
Total value	$2,592,423	$2,611,364	$2,239,108	$2,478,872	$2,567,537
Number of operating firms reporting	117	115	116	99	95
Rank of State	11	11	12	14	14

MARYLAND.

Product.	1906	1907	1908	1909	1910
Brick:					
Common—					
Quantity	204,238,000	166,768,000	141,071,000	148,673,000	164,795,000
Value	$1,267,771	$1,026,922	$828,981	$914,420	$1,051,381
Average per M	$6.21	$6.16	$5.88	$6.15	$6.38
Vitrified—					
Quantity	(a)	(a)	(a)	(a)	(a)
Value	(a)	(a)	(a)	(a)	(a)
Average per M	$15.60	$15.00	$13.06	$13.10	$16.96
Front—					
Quantity	2,266,000	1,597,000	936,000	1,350,000	260,000
Value	$31,968	$19,854	$13,498	$20,582	$3,953
Average per M	$14.11	$12.43	$14.42	$15.25	$15.20
Fancy or ornamental . value	(a)	(a)	$1,463	(a)	(a)
Enameled ... do	(a)	(a)	(a)	(a)	(a)
Fire ... do	$266,980	$242,312	$179,469	$278,777	$296,541
Stove lining ... do	$32,200	$31,048	$23,538	$25,925	$23,067
Draintile ... do	$3,315	$3,190	$3,895	5,695	$5,899
Architectural terra cotta ... do	(a)	(a)	(a)	(a)	(a)
Tile, not drain ... do	(a)	(a)	(a)	....	....
Pottery:					
Red earthenware ... do	$12,733	$12,895	$9,267	$8,034	$9,171
Stoneware and yellow and Rockingham ware .. value	(a)	(a)	(a)	(a)	....
White ware, including C. C. ware, white granite ware, semiporcelain and semivitreous porcelain ware, value	$352,000	$348,890	(a)	(a)	(a)
Sanitary ware ... value	....	....	....	(a)	(a)
Miscellaneous ... do	$169,572	$201,251	$380,988	$467,379	$458,261
Total value	$2,136,539	$1,886,362	$1,441,099	$1,720,812	$1,848,273
Number of operating firms reporting	70	63	65	59	55
Rank of State	15	18	22	21	19

a Included in "Miscellaneous."

Clay products of the United States, by States, from 1906 to 1910—Continued.

MASSACHUSETTS.

Product.	1906	1907	1908	1909	1910
Brick:					
Common—					
Quantity	204,282,000	184,005,000	141,591,000	183,584,000	165,315,000
Value	$1,415,864	$1,294,918	$950,921	$1,177,281	$1,120,924
Average per M	$6.93	$7.04	$6.72	$6.41	$6.78
Front—					
Quantity	(a)	(a)	1,899,000	1,790,000	(a)
Value	(a)	(a)	$34,055	$45,050	(a)
Average per M	$22.17	$37.13	$17.93	$25.17	$15.44
Fancy or ornamental. value	(a)	(a)	(a)	(a)	....
Fire. do	$57,940	$74,115	$63,241	$75,160	$71,780
Stove lining. do	$186,815	$206,042	$169,811	$159,530	$166,018
Architectural terra cotta. do	(a)	(a)	....	(a)	....
Fireproofing. do	(a)	(a)	(a)	(a)	(a)
Tile, not drain. do	$91,394	$123,220	$104,386	$69,837	(a)
Pottery:					
Red earthenware. do	$171,160	$166,978	$150,148	$154,887	$148,909
Stoneware and yellow and Rockingham ware. value	$18,210	$17,693	$15,409	$14,380	$9,654
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)	(a)
Miscellaneous. value	$231,350	$245,854	$159,391	$191,761	$190,128
Total value	$2,172,733	$2,128,820	$1,647,362	$1,887,886	$1,707,413
Number of operating firms reporting	82	80	76	72	71
Rank of State	14	15	18	19	21

MICHIGAN.

Product.	1906	1907	1908	1909	1910
Brick:					
Common—					
Quantity	206,583,000	200,817,000	181,049,000	219,820,000	232,551,000
Value	$1,178,202	$1,181,015	$994,525	$1,250,787	$1,363,316
Average per M	$5.70	$5.88	$5.49	$5.69	$5.86
Vitrified—					
Quantity	6,229,000	7,911,000	6,165,000	10,473,000	9,080,000
Value	$81,814	$94,601	$76,630	$129,283	$116,446
Average per M	$13.13	$11.96	$12.43	$12.34	$12.82
Front—					
Quantity	1,474,000	3,956,000	1,896,000	2,379,000	2,209,000
Value	$14,162	$32,116	$19,496	$18,654	$27,533
Average per M	$9.61	$8.12	$10.28	$7.84	$12.46
Fancy or ornamental. value	(a)	....	....	....	....
Fire. do	(a)	(a)	....	....	....
Stove lining. do	(a)	....	....	....	(a)
Draintile. do	$314,098	$289,868	$327,630	$364,006	$348,205
Sewer pipe. do	(a)	(a)	(a)	(a)	(a)
Fireproofing, terra-cotta lumber, and hollow building tile, or blocks. value	$4,290	$6,386	$4,100	(a)	....
Tile, not drain. do	....	(a)	(a)	(a)	(a)
Pottery:					
Red earthenware. do	$43,510	$54,474	$54,659	$60,939	$90,450
Porcelain electrical supplies, value	....	....	....	....	(a)
Miscellaneous. value	$208,401	$189,304	$251,750	$218,829	$250,272
Total value	$1,844,477	$1,847,764	$1,728,790	$2,042,498	$2,196,222
Number of operating firms reporting	142	136	132	122	118
Rank of State	18	19	17	17	16

a Included in "Miscellaneous."

Clay products of the United States, by States, from 1906 to 1910—Continued.

MINNESOTA.

Product.	1906	1907	1908	1909	1910
Brick:					
Common—					
Quantity	165,598,000	168,931,000	145,712,000	161,585,000	182,895,000
Value	$986,982	$1,045,874	$869,532	$969,729	$1,104,898
Average per M	$5.96	$6.19	$5.97	$6.00	$6.04
Vitrified—					
Quantity	(a)	(a)	(a)	(a)	....
Value	(a)	(a)	(a)	(a)	....
Average per M	$10.68	$12.00	$9.00	$9.00	....
Front—					
Quantity	7,510,000	(a)	9,900,000	14,350,000	7,240,000
Value	$98,170	(a)	$118,860	$171,600	$88,000
Average per M	$13.07	$12.93	$12.01	$11.96	$12.15
Fancy or ornamental. value	....	(a)	(a)	....	....
Fire ... do	(a)	(a)	(a)	....	(a)
Draintile ... do	$41,779	$49,622	$70,161	$109,371	$160,706
Sewer pipe ... do	(a)	(a)	(a)	(a)	(a)
Fireproofing ... do	$23,991	$42,327	$45,940	$53,398	$93,731
Tile, not drain ... do	....	....	....	(a)	....
Pottery:					
Earthenware and stoneware, value	(b)	(b)	(b)	(b)	(b)
Miscellaneous ... value	$452,357	$552,100	$404,217	$451,340	$453,961
Total value	$1,603,279	$1,689,933	$1,508,710	$1,755,438	$1,901,296
Number of operating firms reporting	109	106	92	80	84
Rank of State	23	21	20	20	18

MISSOURI.

Brick:					
Common—					
Quantity	257,292,000	264,462,000	219,526,000	276,403,000	201,281,000
Value	$1,810,304	$1,844,255	$1,465,311	$1,961,805	$1,284,997
Average per M	$7.04	$6.97	$6.67	$7.10	$6.38
Vitrified—					
Quantity	57,414,000	47,807,000	56,805,000	59,863,000	56,703,000
Value	$539,700	$462,341	$647,097	$781,706	$647,441
Average per M	$9.40	$9.67	$11.39	$13.06	$11.42
Front—					
Quantity	29,019,000	30,178,000	32,136,000	36,194,000	38,428,000
Value	$394,563	$387,455	$356,758	$589,782	$516,505
Average per M	$13.59	$12.84	$11.10	$16.30	$13.44
Fancy or ornamental value	$30,689	$33,638	$25,035	$29,683	$23,673
Enameled ... do	(a)	(a)	(a)	(a)	(a)
Fire ... do	$1,324,895	$1,634,209	$1,357,387	$1,598,302	$2,059,845
Stove lining ... do	(a)	(a)	(a)	(a)	(a)
Draintile ... do	$64,063	$72,316	$76,865	$127,166	$121,068
Sewer pipe ... do	$1,208,236	$1,332,080	$962,116	$1,162,730	$1,210,348
Architectural terra cotta .. do	(a)	(a)	(a)	(a)	(a)
Fireproofing, terra-cotta lumber, and hollow building tile or blocks ... value	$130,914	$142,997	$105,136	$110,464	$146,931
Tile, not drain ... do	(a)	(a)	(a)	(a)	(a)
Pottery:					
Red earthenware ... do	$4,429	$3,289	$3,719	$4,792	$3,080
Stoneware and yellow and Rockingham ware .. value	$65,071	$69,323	$62,689	$66,830	$25,981
Miscellaneous ... do	$1,123,411	$916,968	$569,343	$1,006,923	$1,047,897
Total value	$6,696,275	$6,898,871	$5,631,456	$7,440,183	$7,087,766
Number of operating firms reporting	190	172	161	156	150
Rank of State	7	6	7	7	7

[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 1906 to 1910—Continued.

NEBRASKA.

Product.	1906	1907	1908	1909	1910
Brick:					
Common—					
Quantity	119,501,000	117,276,000	114,399,000	139,151,000	119,017,000
Value	$835,702	$789,170	$766,146	$946,532	$791,351
Average per M	$6.99	$6.73	$6.70	$6.80	$6.65
Vitrified—					
Quantity	(a)	2,900,000	(a)	(a)	(a)
Value	(a)	$24,600	(a)	(a)	(a)
Average per M	$8 00	$8 48	$7.59	$10.50	$8.88
Front—					
Quantity	(a)	7,280,000	(a)	(a)	(a)
Value	(a)	$100,654	(a)	(a)	(a)
Average per M	$13.96	$13.83	$13.99	$18.17	$16.00
Fancy ... value	(a)	(a)	(a)		
Fire ... do	(a)		(a)		
Drain tile ... do	(a)	(a)	$12,346	(a)	(a)
Fireproofing ... do	(a)	$29,000	$63,191	(a)	(a)
Miscellaneous ... do	$155,006	$10,008	$104,833	$199,917	$147,476
Total value	$990,708	$953,432	$946,516	$1,146,449	$938,827
Number of operating firms reporting	98	89	90	79	78
Rank of State	27	27	25	26	27

NEW JERSEY.

Product.	1906	1907	1908	1909	1910
Brick:					
Common—					
Quantity	413,258,000	388,735,000	300,544,000	460,966,000	401,103,000
Value	$2,610,686	$2,289,883	$1,579,835	$2,609,605	$2,215,628
Average per M	$6.32	$5.89	$5.26	$5.66	$5.52
Vitrified—					
Quantity	(a)	(a)	(a)	(a)	
Value	(a)	(a)	(a)	(a)	
Average per M	$14.98	$13.31	$11.43	$11.41	
Front—					
Quantity	62,138,000	61,521,000	64,302,000	80,855,000	47,451,000
Value	$896,887	$825,767	$667,682	$862,245	$609,845
Average per M	$14.43	$13.42	$10.38	$10.66	$12.85
Fancy or ornamental ... value	$1,951	$4,605	$3,619	$8,578	(a)
Enameled ... do	(a)	(a)	(a)	(a)	(a)
Fire ... do	$954,081	$947,472	$800 987	$907,276	$1,001,063
Stove lining ... do	(a)	(a)	(a)		(a)
Draintile ... do	$23,209	$21,869	$30,325	$37,211	$23,147
Sewer pipe ... do	(a)	(a)	(a)	(a)	(a)
Architectural terra cotta ... do	$1,682,022	$1,722,067	$1,039,856	$1,637,705	$2,000,039
Fireproofing, terra-cotta lumber, and hollow building tile or blocks ... value	$1,485,195	$1,159,467	$826,224	$1,299,540	$1,582,101
Tile, not drain ... do	$1,163,401	$1,050,085	$835,499	$992,606	$1,199,113
Pottery:					
Red earthenware ... value	$22,068	$21,067	$20,100	$36,573	$26,529
Stoneware and yellow and Rockingham ware ... value	$54,725	(a)	(a)	$66,293	$55,734
White ware, including C. C. ware, white granite semi-porcelain ware, and semi-vitreous porcelain ware, value	$1,436,246	$1,225,691	$1,137,701	$1,242,361	$1,345,156
China, bone china, delft, and belleek ware ... value	$1,065,986	$1,135,885	$876,259	$1,082,398	$1,131,412
Sanitary ware ... do	$3,742,045	$3,615,685	$3,182,772	$4,341,040	$4,955,066
Porcelain electrical supplies, value	$783,549	$744,068	$559,556	$823,056	$874,013
Miscellaneous ... value	$1,440,218	$1,241,849	$753,281	$1,225,607	$815,463
Total value	$17,362,269	$16,005,460	$12,313,696	$17,172,094	$17,834,309
Number of operating firms reporting	175	165	165	165	167
Rank of State	3	3	3	3	3

a Included in "Miscellaneous."

Clay products of the United States, by States, from 1906 to 1910—Continued.

NEW YORK.

Product.	1906	1907	1908	1909	1910
Brick:					
Common—					
Quantity	1,535,579,000	1,319,416,000	1,055,006,000	1,542,552,000	1,380,084,000
Value	$9,205,981	$7,056,453	$5,066,084	$7,760,746	$6,897,438
Average per M	$6.00	$5.35	$4.80	$5.03	$5.00
Vitrified—					
Quantity	10,787,000	18,516,000	14,570,000	16,063,000	21,662,000
Value	$163,969	$253,664	$211,290	$238,697	$334,432
Average per M	$15.20	$13.70	$14.50	$14.86	$15.44
Front—					
Quantity	23,625,000	12,265,000	9,721,000	9,815,000	9,229,000
Value	$351,824	$198,265	$135,342	$148,126	$137,748
Average per M	$14.89	$16.17	$13.92	$15.09	$14.93
Fancy or ornamental. value	...	(a)	(a)	...	(a)
Enameled do	(a)	...	...	...	...
Fire do	$451,783	$538,721	$436,847	$491,872	$514,990
Stove lining do	$131,908	$129,467	$102,985	$79,653	$86,248
Draintile do	$153,237	$180,818	$275,681	$125,640	$272,836
Sewer pipe do	(a)	(a)	$133,716	$126,908	$136,576
Architectural terra cotta do	$967,987	$1,089,278	$709,360	$998,535	$1,108,371
Fireproofing do	$108,059	$120,318	$122,395	$199,999	$210,954
Tile, not drain do	$101,319	$43,726	$40,066	$62,795	$72,815
Pottery:					
Earthenware value	$34,034	$32,896	$31,645	$30,200	$26,863
Stoneware and yellow and Rockingham ware value	$70,131	$87,471	$44,713	$46,905	$43,325
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	$657,817	$746,634	$622,548	$592,611	$642,592
Sanitary ware do	(a)	(a)	(a)	(a)	(a)
Porcelain electrical supplies, value	$663,886	$626,032	$560,754	$752,185	$957,101
Miscellaneous value	$814,672	$669,131	$435,798	$502,564	$429,660
Total value	$13,876,607	$11,772,874	$8,929,224	$12,157,436	$11.871,949
Number of operating firms reporting	253	247	241	243	240
Rank of State	4	5	5	5	5

NORTH CAROLINA.

Product.	1906	1907	1908	1909	1910
Brick:					
Common—					
Quantity	166,338,000	174,800,000	144,192,000	188,313,000	167,966,000
Value	$1,041,078	$1,150,685	$900,611	$1,140,727	$1,039,319
Average per M	$6.26	$6.58	$6.25	$6.06	$6.19
Vitrified—					
Quantity	(a)	(a)	(a)	...	...
Value	(a)	(a)	(a)	...	...
Average per M	$10.00	$10.00	$8.00	...	...
Front—					
Quantity	385,000	770,000	300,000	725,000	550,000
Value	$4,410	$7,925	$2,700	$9,250	$5,800
Average per M	$11.45	$10.29	$9.00	$12.76	$10.55
Fancy value	...	...	...	...	...
Fire do	(a)	(a)	$7,560	...	...
Draintile do	(a)	(a)	$1,635	$8,890	$9,555
Sewer pipe do	(a)	(a)	(a)	(a)	(a)
Fireproofing do	(a)	...	(a)	...	(a)
Pottery:					
Red earthenware do	$713	$2,382	$775	$1,780	$1,961
Stoneware and yellow and Rockingham ware value	$11,057	$7,840	$12,587	$16,929	$13,029
Miscellaneous do	$125,080	$146,990	$18,100	$125,035	$154,000
Total value	$1,182,338	$1,315,822	$943,968	$1,302,611	$1,223,664
Number of operating firms reporting	214	215	216	187	184
Rank of State	26	25	26	25	25

a Included in "Miscellaneous."

Clay products of the United States, by States, from 1906 to 1910—Continued.

OHIO.

Product.	1906	1907	1908	1909	1910
Brick:					
Common—					
Quantity	550,422,000	495,025,000	369,410,000	420,999,000	409,773,000
Value	$3,243,157	$3,012,485	$2,105,910	$2,429,879	$2,507,742
Average per M	$5.89	$6.09	$5.70	$5.77	$6.12
Vitrified—					
Quantity	202,978,000	264,571,000	327,718,000	324,530,000	289,817,000
Value	$1,955,360	$2,672,600	$3,232,335	$3,113,128	$2,876,157
Average per M	$9.63	$10.10	$9.86	$9.59	$9.92
Front—					
Quantity	90,310,000	88,992,000	94,435,000	130,684,000	134,759,000
Value	$1,025,590	$1,033,434	$1,067,888	$1,393,787	$1,489,094
Average per M	$11.36	$11.61	$11.31	$10.67	$11.05
Fancy or ornamental . value	$38,218	$24,468	$39,309	$24,367	$32,995
Fire . do	$1,670,630	$1,668,728	$1,339,810	$1,730,401	$1,709,039
Stove lining . do	$110,800	$22,416	(a)	$23,803	(a)
Draintile . do	$1,520,748	$1,433,341	$1,725,462	$2,032,528	$1,869,823
Sewer pipe . do	$3,987,360	$3,792,352	$3,918,971	$3,009,798	$3,289,537
Architectural terra cotta . do	(a)	(a)	....	(a)	....
Fireproofing, terra-cotta lumber, and hollow building tile or blocks . value	$1,159,021	$1,006,076	$552,887	$804,637	$934,960
Tile, not drain . do	$1,523,410	$1,586,174	$1,438,042	$1,912,343	$1,896,572
Pottery:					
Red earthenware . do	$206,258	$142,042	$138,431	$145,137	$161,799
Stoneware and yellow and Rockingham ware . value	$1,581,732	$1,648,213	$1,468,197	$1,806,798	$1,664,572
White ware, including C. C. ware, white granite, semi-porcelain ware, and semi-vitreous porcelain ware, value	$9,735,072	$9,419,960	$7,228,636	$8,884,189	$9,730,408
China, bone china, delft and belleek ware . value	(a)	(a)	(a)	(a)	....
Sanitary ware . do	$285,000	$226,000	$233,000	$310,254	$327,438
Porcelain electrical supplies, value	$1,100,979	$933,256	$719,034	$1,146,694	$1,277,144
Miscellaneous . do	$1,870,830	$1,719,285	$1,414,578	$1,578,498	$1,758,668
Total value	$31,014,165	$30,340,830	$26,622,490	$30,346,241	$31,525,948
Number of operating firms reporting	784	736	706	685	683
Rank of State	1	1	1	1	1

OKLAHOMA.[b]

Product.	1906	1907	1908	1909	1910
Brick:					
Common—					
Quantity	75,831,000	88,124,000	74,836,000	156,889,000	131,146,000
Value	$486,770	$590,488	$457,588	$952,453	$763,236
Average per M	$6.42	$6.70	$6.11	$6.07	$5.82
Vitrified—					
Quantity	2,269,000	4,528,000	7,681,000	7,186,000	11,959,000
Value	$21,031	$39,676	$71,545	$58,388	$114,315
Average per M	$9.27	$8.76	$9.31	$8.13	$9.56
Front—					
Quantity	1,292,000	1,752,000	1,231,000	1,796,000	2,682,000
Value	$14,562	$20,990	$16,010	$21,473	$35,288
Average per M	$11.27	$11.98	$13.01	$11.96	$13.16
Fancy or ornamental . value	(a)	....	(a)	....	....
Fire—					
Quantity	(a)	(a)	(a)	....	....
Value	(a)	(a)	(a)	....	....
Average per M	$17.10	$15.53	$40.00	....	....
Drain tile . value	....	....	(a)	....	....
Miscellaneous . do	$18,538	$13,358	$17,786	....	$8,082
Total value	$540,901	$664,512	$562,929	$1,032,314	$920,921
Number of operating firms reporting	47	41	33	39	46
Rank of State	34	31	32	28	28

[a] Included in "Miscellaneous." [b] Including Indian Territory in 1906.

Clay products of the United States, by States, from 1906 to 1910—Continued.

PENNSYLVANIA.

Product.	1906	1907	1908	1909	1910
Brick:					
Common—					
Quantity	1,027,541,000	980,102,000	717,016,000	872,658,000	828,703,000
Value	$6,586,374	$6,353,799	$4,539,978	$5,607,490	$5,371,707
Average per M	$6.41	$6.48	$6.33	$6.43	$6.48
Vitrified—					
Quantity	93,417,000	115,729,000	90,044,000	116,735,000	101,330,000
Value	$996,347	$1,232,718	$1,038,254	$1,329,317	$1,204,724
Average per M	$10.67	$10.65	$11.53	$11.39	$11.89
Front—					
Quantity	151,138,000	134,869,000	124,642,000	194,695,000	171,415,000
Value	$1,761,991	$1,526,565	$1,403,594	$2,111,556	$2,001,967
Average per M	$11.66	$11.32	$11.26	$10.85	$11.68
Fancy or ornamental.value	$40,880	$17,727	$49,199	$27,963	$35,768
Enameled do	(a)	(a)	(a)	(a)	(a)
Fire do	$6,854,640	$6,907,904	$4,252,325	$8,107,807	$6,454,928
Stove lining do	$203,674	$179,218	$129,686	$97,270	$132,567
Draintile do	$9,113	$10,386	$14,904	$14,668	$11,480
Sewer pipe do	$985,635	$795,991	$578,800	$445,594	$583,418
Architectural terra cotta do	$367,353	$507,116	$389,596	$428,522	$472,150
Fireproofing, terra-cotta lumber, hollow building tile or blocks value	$242,668	$244,773	$241,175	$324,860	$300,187
Tile, not drain do	$389,013	$406,269	$337,948	$441,243	$413,047
Pottery:					
Red earthenware do	$165,073	$164,096	$138,181	$159,796	$178,348
Stoneware and yellow and Rockingham ware value	$312,150	$380,361	$259,095	$297,029	$323,990
White ware, including C. C. ware, white granite ware, semiporcelain ware, and semivitreous porcelain ware value	$845,366	$531,634	$623,544	$812,338	(a)
China, bone China, delft, and belleek ware value	(a)	(a)	$69,994	$91,757	$188,122
Sanitary ware do	$186,560	$192,854	$175,384	$252,951	$254,747
Porcelain electrical supplies, value				(a)	(a)
Miscellaneous value	$1,827,774	$840,210	$601,325	$636,552	$4,167,135
Total value	$21,774,611	$20,291,621	$14,842,982	$21,186,713	$22,094,285
Number of operating firms reporting	514	487	466	457	451
Rank of State	2	2	2	2	2

TENNESSEE.

Product.	1906	1907	1908	1909	1910
Brick:					
Common—					
Quantity	169,371,000	170,972,000	134,171,000	159,328,000	140,878,000
Value	$1,038,266	$1,036,112	$767,773	$1,022,282	$826,533
Average per M	$6.13	$6.06	$5.72	$6.42	$5.87
Vitrified—					
Quantity	(a)	(a)	(a)	(a)	(a)
Value	(a)	(a)	(a)	(a)	(a)
Average per M	$13.00	$11.98	$11.46	$13.08	$10.80
Front—					
Quantity	12,077,000	15,514,000	9,494,000	11,397,000	10,119,000
Value	$124,031	$169,616	$103,228	$125,661	$98,450
Average per M	$10.27	$10.93	$10.87	$11.03	$9.73
Fancy value	$3,663	$3,087	$1,505	(a)	(a)
Fire do	$45,379	$40,959	$21,029	(a)	$14,907
Draintile do	$19,719	$28,000	$36,114	$67,472	$29,707
Sewer pipe do	(a)	(a)	(a)	(a)	(a)
Fireproofing do	(a)	(a)	(a)	(a)	(a)
Pottery:					
Red earthenware do	(a)	$6,185	(a)	(a)	$4,540
Stoneware and yellow and Rockingham ware value	$163,900	$111,030	$56,532	$35,100	$44,640
Miscellaneous do	$225,268	$218,873	$250,253	$398,357	$395,511
Total value	$1,620,226	$1,613,862	$1,236,434	$1,648,872	$1,414,288
Number of operating firms reporting	116	116	104	100	97
Rank of State	22	22	23	23	24

[a] Included in "Miscellaneous."

Clay products of the United States, by States, from 1906 to 1910—Continued.

TEXAS.

Product.	1906	1907	1908	1909	1910
Brick:					
Common—					
Quantity	211,842,000	243,853,000	194,551,000	293,660,000	271,640,000
Value	$1,307,199	$1,707,812	$1,285,857	$1,890,601	$1,779,062
Average per M	$6.17	$7.00	$6.61	$6.44	$6.55
Vitrified—					
Quantity	(a)	(a)	(a)	(a)	(a)
Value	(a)	(a)	(a)	(a)	(a)
Average per M	$10.00	$10.36	$10.81	$10.32	$13.67
Front—					
Quantity	8,492,000	11,494,000	10,411,000	26,726,000	21,646,000
Value	$110,189	$153,187	$154,298	$407,023	$325,074
Average per M	$12.98	$13.33	$14.82	$15.23	$15.02
Fancy or ornamental..value	(a)	....	....	(a)	....
Fire..do	$45,557	$75,946	$69,039	$123,393	$75,950
Draintile..do	$3,652	(a)	$5,275	$28,414	$18,408
Sewer pipe..do	(a)	(a)	(a)	(a)	(a)
Fireproofing..do	....	....	(a)	$20,170	(a)
Tile, not drain..do	(a)	....	(a)	....	....
Pottery:					
Red earthenware..do	$10,045	$6,759	$10,267	$10,889	$6,481
Stoneware and yellow and Rockingham ware..value	$98,590	$149,414	$114,879	$111,539	$112,604
Miscellaneous..do	$394,366	$464,443	$427,120	$556,434	$546,351
Total value	$1,969,598	$2,557,561	$2,066,735	$3,148,463	$2,863,930
Number of operating firms reporting	139	131	122	113	124
Rank of State	16	12	14	11	12

VIRGINIA.

Product.	1906	1907	1908	1909	1910
Brick:					
Common—					
Quantity	232,697,000	197,052,000	185,738,000	249,794,000	229,982,000
Value	$1,536,312	$1,285,374	$1,219,946	$1,540,648	$1,460,460
Average per M	$6.60	$6.52	$6.57	$6.17	$6.35
Front—					
Quantity	25,385,000	19,989,000	17,858,000	24,717,000	20,813,000
Value	$393,130	$290,411	$246,623	$333,057	$294,348
Average per M	$15.45	$14.53	$13.81	$13.47	$14.14
Fancy or ornamental..value	(a)	(a)	(a)	(a)	(a)
Fire..do	$21,110	(a)	(a)	(a)	(a)
Draintile..do	$4,805	$6,250	$7,100	$6,298	$5,276
Sewer pipe..do	....	....	(a)	(a)	(a)
Porcelain electrical supplies, value	(b)	(b)	(b)	(a)	(a)
Miscellaneous..value	$11,721	$29,300	$25,461	$76,514	$79,603
Total value	$1,966,078	$1,611,335	$1,499,130	$1,956,517	$1,839,687
Number of operating firms reporting	91	87	80	89	84
Rank of State	17	23	21	18	20

a Included in "Miscellaneous."

b The value of pottery products for Virginia for 1906, 1907, and 1908 could not be included in the State total without disclosing individual figures.

Clay products of the United States, by States, from 1906 to 1910—Continued.

WASHINGTON.

Product.	1906	1907	1908	1909	1910
Brick:					
Common—					
Quantity	99,788,000	101,905,000	107,638,000	143,198,000	130,634,000
Value	$708,968	$846,971	$817,962	$1,081,579	$956,510
Average per M	$7.10	$8.31	$7.60	$7.55	$7.32
Vitrified—					
Quantity	9,609,000	(a)	(a)	(a)	(a)
Value	$156,476	(a)	(a)	(a)	(a)
Average per M	$16.28	$18.22	$19.82	$18.72	$18.87
Front—					
Quantity	4,439,000	4,539,000	4,011,000	7,802,000	5,570,000
Value	$122,770	$127,245	$112,749	$155,600	$124,952
Average per M	$27.66	$28.03	$28.11	$19.94	$22.43
Fancy....value	....	....	....	....	....
Fire....do	$46,525	$43,940	$42,045	$103,531	$25,017
Draintile....do	$13,057	$17,025	$28,551	$18,495	$34,128
Sewer pipe....do	$313,880	$482,870	$493,165	$737,847	$817,086
Architectural terra cotta..do	(a)	$94,795	$171,845	$206,324	$198,358
Fireproofing....do	$15,905	(a)	$45,205	$71,067	$114,501
Tile, not drain....do	(a)	....	....	....	....
Pottery:					
Red earthenware....value	$5,500	$2,500	$2,450	(a)	(b)
Stoneware and yellow and Rockingham ware..value	$36,060	$28,195	(a)	(a)	(b)
Miscellaneous....do	$80,743	$278,393	$390,317	$686,043	$753,302
Total value	$1,499,884	$1,921,934	$2,104,289	$3,060,486	$3,023,854
Number of operating firms reporting	61	63	67	65	65
Rank of State	24	17	13	12	11

WEST VIRGINIA.

Product.	1906	1907	1908	1909	1910
Brick:					
Common—					
Quantity	74,833,000	58,102,000	47,402,000	53,983,000	77,916,000
Value	$469,527	$384,007	$300,776	$327,141	$508,422
Average per M	$6.27	$6.61	$6.35	$6.06	$6.53
Vitrified—					
Quantity	47,902,000	60,681,000	70,924,000	45,661,000	46,098,000
Value	$578,164	$952,060	$718,017	$565,218	$564,578
Average per M	$12.07	$15.69	$10.12	$12.38	$12.25
Front—					
Quantity	(a)	(a)	(a)	(a)	(a)
Value	(a)	(a)	(a)	(a)	(a)
Average per M	$15.00	$15.16	$14.18	$14.74	$10.00
Fire....value	$59,757	$34,438	$38,943	$80,773	$32,003
Draintile....do	(a)	$1,211	$2,645	(a)	$2,330
Sewer pipe....do	(a)	....	(a)	(a)	(a)
Fireproofing....do	....	(a)	(a)	(a)	(a)
Tile, not drain....do	(a)	$52,429	$49,220	$82,461	$104,633
Pottery:					
Stoneware and yellow and Rockingham ware..value	$23,200	(a)	(a)	(a)	(a)
White ware, including C. C. ware, white granite ware, semiporcelain ware, and semivitreous porcelain ware....value	$1,047,770	$1,651,732	$1,612,321	$1,769,808	$1,894,429
Sanitary ware....do	$387,000	$378,000	$385,000	$500,432	$618,868
Porcelain electrical supplies, value	(a)	(a)	(a)	....	(a)
Miscellaneous....value	$217,894	$186,510	$154,814	$184,264	$272,782
Total value	$2,783,312	$3,640,387	$3,261,736	$3,510,097	$3,998,045
Number of operating firms reporting	65	63	60	50	56
Rank of State	10	10	10	10	10

[a] Included in "Miscellaneous."

[b] The value of pottery products for Washington for 1910 could not be included in the State totals without disclosing the operations of individual establishments.

Clay products in the United States, from 1906 to 1910—Continued.

WISCONSIN.

Product	1906	1907	1908	1909	1910
Brick:					
Common—					
Quantity	170,496,000	158,602,000	129,041,000	147,741,000	161,083,000
Value	$1,109,386	$1,019,522	$830,249	$956,232	$1,071,457
Average per M	$6.51	$6.43	$6.43	$6.47	$6.65
Vitrified—					
Quantity	....	(a)	....	....	....
Value	....	(a)	....	....	....
Average per M	....	$8.04	....	....	....
Front—					
Quantity	5,384,000	4,106,000	4,646,000	7,788,000	2,400 000
Value	$52,038	$43,387	$41,569	$74,120	$29,900
Average per M	$9.67	$10.57	$8.95	$9.52	$12.46
Fancy or ornamental. value	(a)	(a)	(a)	(a)	(a)
Fire ..... do	....	....	....	(a)	....
Draintile ..... do	$51,143	$49,832	$74,702	$95,899	$64,391
Fireproofing ..... do	$810	$1,595	(a)	(a)	....
Tile, not drain ..... do	....	....	(a)	....	....
Pottery:					
Earthenware ..... do	$11,470	$8,832	$9,300	$9,109	$8,965
Stoneware ..... do	....	....	....	(a)	....
Miscellaneous ..... do	$2,495	$4,651	$2,575	$4,229	$2,170
Total value	$1,227,342	$1,127,819	$958,395	$1,139,589	$1,176,883
Number of operating firms reporting	147	138	121	106	112
Rank of State	25	26	24	27	26

a Included in "Miscellaneous."

CLAY.

INTRODUCTION.

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 clays 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 1910, in common with the clay-working industries, showed progress. The total quantity and value were the largest ever recorded. The increase over 1909, although not as large as that of 1909 over 1908, was large enough to indicate that the industry is on a sound basis and is gradually growing in importance. The average price per ton declined for every variety except one, which is contrary to the experience of the brick and tile industry, in which in every variety of brick for which prices were obtained, except one, there was an increase in the average price. The imports of clay, which consist principally of kaolin, increased slightly, but less in proportion than domestic production.

PRODUCTION.

The following table shows the production of clay in 1909 and 1910 by varieties:

Production of clay in the United States in 1909 and 1910, by kinds, in short tons.

Kind.	1909			1910		
	Quantity.	Value.	Average price per ton.	Quantity.	Value.	Average price per ton.
Kaolin	31,227	$241,060	$7.72	34,221	$255,873	$7.48
Paper clay	81,586	386,764	4.74	85,949	420,476	4.89
Slip clay	18,010	30,527	1.70	17,696	29,962	1.69
Ball clay	49,074	214,194	4.36	70,637	257,265	3.64
Fire clay	1,463,919	2,082,193	1.42	1,638,931	2,157,720	1.32
Stoneware clay	130,757	137,264	1.05	152,942	153,044	1.00
Brick clay	222,686	171,183	.77	173,625	128,039	.74
Miscellaneous	162,388	186,522	1.15	215,228	223,106	1.04
Total	2,159,647	3,449,707	1.60	2,389,229	3,625,485	1.52

This table shows that the total quantity of clay mined and sold as such in 1910 was 2,389,229 short tons as compared with 2,159,647 short tons in 1909, a gain of 229,582 tons, or 10.63 per cent. The value of the clay mined in 1910 was $3,625,485, an increase over 1909 of $175,778, or 5.10 per cent. Kaolin showed an increase of 2,994 tons, or 9.59 per cent, in quantity and of $14,813, or 6.14 per cent, in value. The average price per ton for kaolin decreased 24 cents per ton in 1910. Ball clay showed the largest proportionate increase in both quantity and value, the former gaining 43.94 per cent and the latter 20.11 per cent. Fire clay, the principal variety in both quantity and value, showed an increase of 175,012 tons, or 11.96 per cent, and of $75,527, or 3.63 per cent. This clay constituted 68.60 per cent of the total quantity of clay mined and its value was 59.52 per cent of the value of all clay. The average price per ton for every variety except one—paper clay—declined, the largest decrease being in ball clay, which fell 72 cents.

The following table shows the production and value of clay in the United States from 1905 to 1910, by varieties:

Clay mined and sold in the United States, 1905–1910, in short tons.

Year.	Kaolin.		Paper clay.		Slip clay.		Ball clay.		Fire clay.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1905	44,675	$326,835	76,339	$307,238	24,565	$33,384	61,345	$167,212	1,229,647	$1,529,468
1906	51,937	369,452	75,963	342,708	21,427	31,546	54,173	199,073	1,380,472	1,878,011
1907	47,645	340,311	66,191	293,943	20,325	37,925	52,413	195,515	1,474,462	2,054,698
1908	28,649	216,243	64,510	310,943	10,087	22,370	40,838	133,770	1,101,579	1,486,139
1909	31,227	241,060	81,586	386,764	18,010	30,527	49,074	214,194	1,463,919	2,082,193
1910	34,221	255,873	85,949	420,476	17,696	29,962	70,637	257,265	1,638,931	2,157,720

Clay mined and sold in the United States, 1905–1910, in short tons—Continued.

Year.	Stoneware clay.		Brick clay.[a]		Miscellaneous clay.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1905	181,485	$219,767			188,077	$184,102	1,806,133	$2,768,006
1906	146,861	150,774			296,619	273,692	2,027,452	3,245,256
1907	125,060	136,576	136,515	$112,003	261,068	277,577	2,183,679	3,448,548
1908	124,192	102,390	210,556	154,575	143,490	173,556	1,723,901	2,599,986
1909	130,757	137,264	222,686	171,183	162,388	186,522	2,159,647	3,449,707
1910	152,942	153,044	173,625	128,039	215,228	223,106	2,389,229	3,625,485

[a] Included in miscellaneous in 1905 and 1906.

This table shows that the quantity of the clay mined in the period covered has risen steadily, except in 1908, from 1,806,133 tons in 1905 to 2,389,229 tons in 1910, an increase of 583,096 tons, or 32.28 per cent. The value has increased from $2,768,006 in 1905 to $3,625,485 in 1910, an increase of $857,479, or 30.98 per cent. Kaolin attained its maximum production and value in 1906. In 1907 and 1908 it fell sharply, but since that time it has risen again. Paper clay, ball clay, and fire clay showed their maximum quantity and value in 1910. Slip clay showed its maximum quantity in 1905 and its maximum value in 1907. Stoneware clay attained its maximum quantity and value in 1905; from 1906 to 1908 it decreased and in 1909 and 1910 it increased in both quantity and value.

The following table shows the production of clay in the United States in 1909 and 1910 by States and varieties:

Clay mined and sold in the United States in 1909, by States, in short tons.

States.	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

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.

Clay mined and sold in the United States in 1910, by States, in short tons.

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									54,482	$32,395			(b)	(b)	17,600	$3,700	75,082	$38,045
Arizona c	(b)	(b)							642	4,030	(b)	(b)	(b)	(b)	805	805	15,595	124,035
California									39,104	63,829	8,341	$5,925	(b)	(b)	14,880	21,234	70,465	104,163
Colorado									29,410	31,467			61,402	$40,883	15,062	11,505	105,874	83,855
Delaware	(b)	(b)							(b)	(b)							11,117	60,744
Florida							27,400	$134,512	(b)	(b)							27,403	134,542
Georgia			36,571	$184,529					7,821	6,031	2,879	8,656			19,021	24,569	66,292	223,785
Illinois									82,878	111,078	42,410	34,202	13,704	16,344	49,811	29,272	188,803	190,896
Indiana					(b)	(b)			77,525	69,184	3,232	4,025	(b)	(b)	3,799	4,450	88,176	80,829
Iowa									(b)	(b)			(b)	(b)	700	210	12,640	5,153
Kentucky					(b)	(b)	(b)	(b)	60,342	45,962	(b)	(b)	728	401	(b)	(b)	80,420	85,655
Maryland	(b)	(b)							17,490	31,024	2,100	2,650	1,150	1,125	256	344	22,696	46,143
Massachusetts									931	1,911	(b)	(b)	(b)	(b)			1,922	2,985
Michigan					1,363	$3,889							(b)	(b)	(b)	(b)	1,424	4,394
Missouri	(b)	(b)							282,834	488,365	1,246	1,294	(b)	(b)	439	466	287,445	509,433
Montana									7,011	10,069							7,011	10,069
New Jersey							(b)	(b)	286,854	468,890	21,099	45,171	30,645	28,683	64,097	97,685	405,591	657,805
New Mexico									14,235	30,727							14,235	30,727
New York					(b)	(b)			(b)	(b)					1,424	1,561	5,880	13,241
Ohio					(b)	(b)			231,568	172,162	57,087	39,307	(b)	(b)	4,700	5,257	325,308	228,255
Pennsylvania	4,303	$23,411	20,327	117,021					345,388	478,619	9,066	5,760	6,499	5,025	10,655	6,777	396,238	636,613
South Carolina			29,051	118,926					(b)	(b)					210	181	29,920	122,567
Tennessee							32,344	82,994	17,122	24,454	4,913	5,578			7,028	7,727	61,407	120,753
Texas									1,114	5,786							1,114	5,786
Utah									6,209	8,903							6,209	8,903
Vermont	5,900	33,200							(b)	(b)					(b)	(b)	6,060	34,038
Virginia									499	1,475					31	11	530	1,486
Washington									3,451	5,932					400	1,200	3,851	7,132
West Virginia									65,335	47,623			(b)	(b)	3,695	3,620	69,630	51,543
Wisconsin											(b)	(b)	(b)	(b)	50	100	359	518
Wyoming															532	1,392	532	1,392
Other States d	24,018	199,262			16,333	26,073	10,893	39,759	6,686	17,804	569	476	59,497	35,578	33	1,040	(e)	(e)
Total	34,221	255,873	85,949	420,476	17,696	29,962	70,637	257,265	1,638,931	2,157,720	152,942	153,044	173,625	128,039	215,228	223,106	2,389,229	3,625,485

a Including bentonite, modeling clay, pipe clay, terra cotta clay, and clay for medicinal use.
b Included in "Other States."

The leading clay-producing State in 1910, as for several years, in both quantity and value, was New Jersey. In 1910 the output in this State decreased 4,512 tons, or 1.10 per cent, and the value decreased $36,761, or 5.29 per cent. In 1910 New Jersey reported 16.98 per cent of the quantity of clay produced and 18.14 per cent of its total value. Of New Jersey's total clay production fire clay was 70.72 per cent in quantity and 71.28 per cent in value. The average value per ton of all clay in 1910 in New Jersey was $1.62; in 1909 it was $1.69; and in 1908 $1.62. Pennsylvania was the second State in the production and value of clay in 1910, as for several years, and reported 16.58 per cent of the total clay produced in the country and 17.56 per cent of the value. There was a small increase in the quantity of clay mined in Pennsylvania in 1910—16,851 tons, and a slight decrease in value—$7,798. The average price per ton of all clay in Pennsylvania in 1910 was $1.61, as compared with $1.70 in 1909. In this State also fire clay was the leading variety, 87.17 per cent of the quantity and 75.18 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. These were the relative ranks in 1909 also. Ohio showed an increase over 1909 of 40,826 tons, or 14.35 per cent, in quantity and of $11,712, or 5.41 per cent, in value. Missouri showed a gain of 72,918 tons, or 33.99 per cent, and of $46,765, or 10.11 per cent. These four States produced 1,414,582 tons of clay in 1910, or 59.21 per cent of the total quantity, and the value of this clay was $2,032,106, or 56.05 per cent of the total. The average price received per ton for all clay in 1910 in Ohio was 70 cents and in Missouri $1.77; in 1909 these averages were 76 cents and $2.16, respectively.

Fifteen States reported increase in production in 1910 and 12 reported increase in value; 10 reported decrease in quantity and 13 reported decrease in value; 11 reported increase in both quantity and value; and 9 reported decrease in both quantity and value. Alabama, New York, Pennsylvania, and Vermont reported increase in quantity and decrease in value, and Massachusetts showed a decrease in quantity and an increase in value. Pennsylvania was the largest producer of fire clay, though it was second in value; New Jersey was second in quantity, but third in value; Missouri was third in quantity and first in value; Ohio was fourth in both quantity and value. The average price per ton of fire clay in these four States in 1910 was: Missouri, $1.73; New Jersey, $1.63; Ohio, $0.74; and Pennsylvania, $1.39. In 1909 these prices were $2.05, $1.73, $0.82, and $1.44, respectively. These four States produced 1,146,644 tons, or 69.96 per cent, of the total quantity, valued at $1,608,036, or 74.52 per cent of the total value of fire clay in 1910.

IMPORTS.

The following table shows the imports of clay from 1906 to 1910:

Classified imports of clay for consumption, 1906–1910, 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.
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
1910	257,902	1,593,472	6.18	27,890	113,352	1,496	26,205	21,176	181,334	308,464	1,914,363

The imports of clay, except of kaolin or china clay, are unimportant. In 1910, of the clay imported, 83.61 per cent of the quantity and 83.24 per cent of the value was kaolin or china clay.

The total quantity of clay imported in 1910 increased 17,684 tons, or 6.08 per cent, and the total value increased $118,573, or 6.60 per cent. To this increase in quantity kaolin contributed 11,521 tons and common blue clay 8,830 tons, while unwrought and wrought clay together decreased 2,667 tons. Of the increase in value of imported clay, kaolin contributed $87,693 and common blue clay $76,933, while wrought and unwrought together decreased $46,053.

KAOLIN IN EDWARDS COUNTY, TEX.

Attention has again been directed to the deposit of kaolin in Texas, near Leakey, Edwards County, by a notice to the press from the Bureau of Economic Geology, University of Texas, Dr. Wm. B. Phillips, director, concerning this deposit.

This clay has been known for several years. It has been thoroughly tested and has been found to be in many respects a very high-grade clay, possibly the best yet discovered in this country. The title to the property is in litigation, which has caused some delay in the development; but the principal cause for the tardy development is inaccessibility of the deposit. It is between 40 and 50 miles from a railroad, and the expense of this long haul precludes the use of the material on a commercial scale.

Dr. Phillips states that a shipment of this clay was made to France, where some ware was manufactured. Unfortunately the pieces made abroad have been broken or lost, but they are said to have shown extreme beauty of design and to have demonstrated that the kaolin was adapted to the production of the finest kinds of porcelain.

Shipments to Ohio potters have been used successfully in the manufacture of high-grade china, and more of the clay would be used if it could be obtained.

In Volume X of the Transactions of the American Ceramic Society appears a paper on this kaolin by Mr. Arthur Mayer, of Beaver Falls, Pa. Mr. Mayer describes the sample received as free from mineral impurities and moisture, being a snow-white powder. The grains were not fine. Considerable grit was present. After being blunged for an hour it gave a residue of 8.2 per cent, showing that it needs some treatment before being used in a body.

The tensile strength of this clay is very high, being 89 pounds to the square inch, compared with other china clays mentioned by Mr.

Mayer, which run from 15.3 to 28.1 pounds to the square inch. The tensile strength of some ball clays run as high as 39.5.

Mr. Mayer found this clay to be very high in plasticity, and his finding was confirmed by H. E. Ashley in the preparation of United States Geological Survey Bulletin 388, "Colloid matter in clay." In this work a series of over 40 clays was used, and the Edwards County clay was found to be the most plastic of all.

Mr. Mayer found that the contraction from the mold to a white hard piece of ware was 10 per cent, which is a large shrinkage, as most china clays shrink from 3.5 to 4 per cent. Trials were burnt to cone 10, at which temperature there was practically no absorption, although ink would spot it so that it could not be washed off. The contraction due to fire was 12 per cent, making the total shrinkage 22 per cent, which is very large, the usual average being from 11 to 16 per cent for china clay, and from 16 to 19 per cent for ball clay. The hardness when burnt by Mr. Mayer was greater than that of tool steel. The color to which the clay burns is one of its best features. Mr. Mayer says that he has found no other clay that would burn as white as this, and that it was far ahead of any English or American clay then (1908) on the market. He found it rather low in iron. But for this he would class it as a ball clay rather than as a kaolin. He attributes the white color to the low iron content and the high lime content.

The following is an analysis of the Texas kaolin and of a well-known English clay:

Analysis of clay from Edwards County, Tex., and from England.

	Texas kaolin.	Whiteways English ball clay.
	Per cent.	*Per cent.*
SiO_2	43.75	44.92
Al_2O_3	37.62	38.68
Fe_2O_3	.36	.92
$CaCO_3$	1.40	.74
Loss on ignition	15.84	10.62
Alkalies	.96	3.68
	99.93	99.56

Mr. Mayer made a trial body as follows:

Spar	700
Calcium carbonate	88
Texas clay	1,560
Ball clay	240
Flint	1,412
	4,000

This body was fired to cone 8, down. The resulting piece of ware was translucent and well vitrified and better in color than any earthenware made in this country. Mr. Mayer thinks the body would have been better if it had contained a little more spar and had been burned to a higher temperature. In the green state it had a tensile strength of 142.3 pounds to the square inch, which would insure a very small loss in handling. Mr. Mayer, in summing up, says that he has seen no other china clay that would compare with the Texas clay in color, vitrification, strength, or plasticity.

BUILDING OPERATIONS.

The following tables show the building operations of some of the leading cities of the country. An effort was made to obtain detailed figures for all cities of 35,000 or more inhabitants—157 in number. For 127 cities sufficient detail was received to include these cities in a table; for 18 cities only the totals for permits and cost of buildings could be obtained; and for 12 cities data were not procured.

The first table shows a comparison between 1909 and 1910 in 51 cities, also the increase or decrease in the cost of building operations in each of these cities and the total decrease in 1910.

Used as an index of prosperity, the figures here given show that the building industries were not as prosperous as in 1909. Where an exact comparison could be made, the decrease of nearly 5 per cent was recorded.

Building operations in a number of the leading cities of the United States in 1909 and 1910.

City.	1909		1910		Increase (+) or decrease (−) in 1910.	Percentage of increase or decrease in 1910.	Rank of cities in cost of buildings in 1910.
	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.			
Atlanta, Ga	4,399	$5,551,951	4,001	$6,645,167	+$1,093,216	+ 19.69	30
Baltimore, Md	3,076	9,761,788	2,841	11,771,680	+ 2,009,892	+ 20.59	19
Boston, Mass	3,702	16,756,431	3,608	20,869,671	+ 4,113,240	+ 24.55	7
Brooklyn, N. Y	13,756	64,267,301	9,892	39,233,098	−25,034,203	− 38.95	3
Buffalo, N. Y	3,361	9,895,000	2,494	9,232,000	− 663,000	− 6.70	24
Cambridge, Mass	490	2,249,745	389	2,339,900	+ 90,155	+ 4.01	65
Chicago, Ill	21,941	95,238,380	23,255	101,098,700	+ 5,860,320	+ 6.15	2
Cincinnati, Ohio	3,181	7,429,529	4,050	8,052,870	+ 623,341	+ 8.39	26
Cleveland, Ohio	6,834	13,028,294	7,460	13,948,413	+ 920,119	+ 7.06	14
Columbus, Ohio	1,790	3,598,601	2,363	5,133,591	+ 1,534,990	+ 42.66	36
Dayton, Ohio	794	1,700,500	1,082	2,015,000	+ 314,500	+ 18.49	77
Denver, Colo	3,270	11,554,983	2,683	11,319,955	− 235,028	− 2.03	20
Detroit, Mich	4,399	14,301,450	5,498	17,415,950	+ 3,114,500	+ 21.78	11
Fall River, Mass	461	1,146,702	469	1,544,129	+ 397,427	+ 34.66	90
Grand Rapids, Mich	1,290	2,872,427	1,268	2,255,621	− 616,806	− 21.47	71
Hartford, Conn	863	3,440,925	1,053	4,541,979	+ 1,101,054	+ 32.00	40
Indianapolis, Ind	3,931	7,156,560	5,112	8,194,311	+ 1,037,751	+ 14.50	25
Jersey City, N. J	1,466	6,882,610	1,522	6,932,570	+ 49,960	+ .73	28
Kansas City, Kans	728	1,196,390	800	1,101,356	− 95,034	− 7.94	110
Kansas City, Mo	4,194	13,367,730	3,147	12,819,690	− 548,040	− 4.10	17
Los Angeles, Cal	8,522	13,256,329	10,738	21,684,100	+ 8,427,771	+ 63.58	5
Louisville, Ky	2,823	2,972,505	2,468	3,996,792	+ 1,024,287	+ 34.46	49
Lowell, Mass	506	1,328,853	562	1,777,654	+ 448,801	+ 33.77	81
Memphis, Tenn	2,556	4,324,377	3,419	6,280,498	+ 1,956,121	+ 45.23	31
Milwaukee, Wis	5,068	11,841,713	4,086	9,797,580	− 2,044,133	− 17.26	23
Minneapolis, Minn	6,055	13,092,390	6,225	14,363,830	+ 1,271,440	+ 9.71	13
Nashville, Tenn	2,231	1,676,572	2,010	1,541,945	− 134,627	− 8.03	91
Newark, N. J	3,082	14,177,159	3,001	13,394,812	− 782,347	− 5.52	15
New Bedford, Mass	986	6,267,650	1,179	7,037,337	+ 769,687	+ 12.28	27
New Haven, Conn	1,047	4,226,322	1,035	4,386,065	+ 159,743	+ 3.78	43
New Orleans, La	2,795	5,165,212	2,530	4,483,730	− 681,482	− 13.19	41
New York, N. Y	7,629	186,047,477	6,877	154,075,625	−31,971,852	− 17.18	1
Oakland, Cal	3,286	5,318,512	3,968	6,913,643	+ 1,595,131	+ 29.99	29
Omaha, Nebr	1,606	7,204,140	1,533	6,250,988	− 953,152	− 13.23	32
Philadelphia, Pa	17,294	42,881,370	16,383	37,866,565	− 5,014,805	− 11.69	4
Pittsburgh, Pa	2,503	14,026,888	3,903	12,753,664	− 1,273,224	− 9.08	18
Portland, Oreg	4,739	13,481,380	6,523	20,886,202	+ 7,404,822	+ 54.93	6
Providence, R. I	1,788	5,340,500	2,306	4,935,300	− 405,200	− 7.59	39
Reading, Pa	458	1,046,900	411	1,054,555	+ 7,655	+ .73	111
Richmond, Va	1,378	3,574,812	1,397	4,012,822	+ 438,010	+ 12.25	48
Rochester, N. Y	3,122	9,272,132	3,456	10,082,528	+ 810,396	+ 8.74	21
St. Joseph, Mo	937	2,255,759	772	1,129,931	− 1,125,828	− 49.91	108
St. Louis, Mo	9,279	23,733,272	9,419	19,600,063	− 4,133,209	− 17.42	9
St. Paul, Minn	4,158	12,158,354	3,809	10,053,006	− 2,105,348	− 17.32	22
San Francisco, Cal	5,773	26,184,068	5,690	20,508,556	− 5,675,512	− 21.68	8
Scranton, Pa	975	3,987,943	894	2,085,948	− 1,901,995	− 47.69	75
Seattle, Wash	14,884	19,044,335	13,082	17,418,078	− 1,626,257	− 8.54	10
Syracuse, N. Y	1,573	4,855,811	1,701	5,019,032	+ 163,221	+ 3.36	38
Toledo, Ohio	1,314	2,014,462	1,732	4,058,188	+ 2,043,726	+101.45	47
Washington, D. C	9,935	15,468,635	5,847	16,278,658	+ 810,023	+ 5.24	12
Worcester, Mass	1,270	4,314,435	1,514	3,919,652	− 394,783	− 9.15	51
Total	213,498	771,937,564	212,457	734,112,998	−37,824,566	− 4.90	....

Of the 51 cities included in this table 29 showed increase in 1910 over 1909 and 22 showed decrease. The total increase was $49,591,299; the total decrease was $87,415,865—a net decrease of $37,824,566, or 4.90 per cent. In 1909, of these same cities 45 showed increase over 1908 and 6 showed decrease, the net increase for that year being $205,772,160, or 36.34 per cent. Compared with 1908 there was an increase in 1910 of $167,947,594, or 29.66 per cent. The greatest increase in 1910 was in Los Angeles, Cal., $8,427,771, or 63.58 per cent. The largest proportionate gain was in Toledo, Ohio, where the cost of building operations in 1910 was more than twice as large as that of 1909. The largest decrease was in New York—$31,971,852, or 17.18 per cent. The next largest decrease was in Brooklyn—$25,034,203, or 38.95 per cent. These two cities contributed 65.21 per cent of the total decrease. The largest proportionate decrease was in St. Joseph, Mo.—49.91 per cent.

Of the 6 cities that showed decrease in 1909, Dayton, Oakland, and Toledo showed increase in 1910. The last two more than regained their losses of 1909 and in 1910 exceeded the cost of building operations of 1908. Nashville, New Orleans, and San Francisco showed decrease in both 1909 and 1910. San Francisco's building operations have undoubtedly reached a normal condition after the abnormal conditions obtaining following the great fire of 1906. The annual cost of building operations in that city since 1904 has been as follows: 1905, $18,268,753; 1906, $34,927,396; 1907, $56,574,844; 1908, $31,668,341; 1909, $26,184,068; and 1910, $20,508,556.

The total number of permits or buildings fell from 213,498 in 1909 to 212,457 in 1910, a decrease of 1,041, or 0.49 per cent; in 1909 there was an increase of 38,904, or 22.28 per cent. The number of permits ranged in 1910 from 389 in Cambridge to 23,255 in Chicago. The average cost of operations in these 51 cities in 1910 was $3,455 per building or permit; in 1909 it was $3,616; and in 1908 it was $3,243. In New York the average cost was $22,404 in 1910, $24,387 in 1909, and $19,305 in 1908. In Chicago the average cost was $4,347 in 1910, $4,341 in 1909, and $6,327 in 1908. In Brooklyn, the third largest city in cost of building operations, the average cost was $3,966 in 1910, $4,672 in 1909, and $4,259 in 1908. In Philadelphia the average was $2,311 in 1910, $2,480 in 1909, and $2,107 in 1908. In San Francisco the average was $3,604 in 1910, $4,536 in 1909, $4,706 in 1908, and $8,789 in 1907.

These 51 cities reported 80.11 per cent of the total cost of the building operations of the 145 cities given on the following pages.

The following table shows the building operations in the leading 145 cities of the country in 1910. Figures are given in such detail as could be furnished by the various city officials, showing the kinds of buildings erected and the additions, alterations, and repairs to each class of buildings. These figures by kinds of buildings are of course not exact, as in some cities, notably Baltimore, Brooklyn, Erie, Washington, and Youngstown, figures for brick buildings include other classes of buildings. It is believed, however, that for wooden buildings and for the more substantially constructed buildings, designated in these tables as fire resisting, the figures are fairly accurate. For 18 cities it is possible to give only the totals for permits and for the cost of all building operations.

Building statistics of the leading cities of the United States, by character of operations, in 1910.

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	65	$36,250	17	$8,000	82	$44,250
Altoona, Pa	233	329,248	491	138,264	724	467,512
Atlanta, Ga	1,362	2,887,010	a 2,434	a 876,811	a 3,796	a 3,763,821
Augusta, Ga	35	83,650	901	73,815	936	157,465
Baltimore, Md	162	803,370			162	803,370
Bay City, Mich	84	84,750	12	4,325	96	89,075
Bayonne, N. J	306	1,148,181	172	95,724	478	1,243,905
Berkeley, Cal	(b)	b 1,486,990		(b)	(b)	b 1,486,990
Binghamton, N. Y	332	471,800	272	119,678	604	591,478
Birmingham, Ala	1,107	2,184,277	1,279	302,876	2,386	2,487,153
Boston, Mass	1,051	5,116,975	962	688,460	2,013	5,805,435
Bridgeport, Conn	300	579,478	190	202,509	490	781,987
Brockton, Mass	285	906,115	209	187,420	494	1,093,535
Brooklyn, N. Y	1,664	4,784,715	2,301	1,143,925	3,965	5,928,640
Buffalo, N. Y	1,923	4,301,960	1,140	823,590	3,063	5,125,550
Cambridge, Mass	152	906,650	178	126,175	330	1,032,825
Camden, N. J	66	100,500	312	80,400	378	180,900
Canton, Ohio	587	751,220	42	28,125	629	779,345
Charleston, S. C	102	208,815	339	81,088	441	289,903
Chester, Pa	9	5,000			9	5,000
Chicago, Ill	3,825	9,562,500	7,786	2,335,800	11,611	11,898,300
Cincinnati, Ohio	731	1,497,490	858	596,810	1,589	2,094,300
Cleveland, Ohio	3,116	4,414,660	3,055	869,209	6,171	5,283,869
Dallas, Tex	1,071	1,594,732	476	267,620	1,547	1,862,352
Davenport, Iowa	141	554,929			141	554,929
Denver, Colo	119	95,850	33	16,125	152	111,975
Des Moines, Iowa	463	729,437	25	18,750	488	748,187
Detroit, Mich	4,079	7,866,385	619	426,195	4,698	8,292,580
Dubuque, Iowa	(c)	200,000	(c)	53,000	77	253,000
Duluth, Minn	778	1,255,089	488	192,630	1,266	1,447,719
East St. Louis, Ill	311	502,264	87	30,411	398	532,675
Elizabeth, N. J	321	979,995	122	80,955	443	1,060,950
Elmira, N. Y	62	186,000	28	36,300	90	222,300
El Paso, Tex						
Erie, Pa	482	715,245	251	165,280	733	880,525
Evansville, Ind	362	304,848	479	76,186	841	381,034
Fall River, Mass	282	769,495	146	144,180	428	913,675
Fitchburg, Mass	144	390,520	90	75,470	234	465,990
Fort Wayne, Ind	476	915,325	162	98,640	638	1,013,965
Galveston, Tex	53	71,355	99	32,270	152	103,625
Grand Rapids, Mich	728	1,148,609	376	200,234	1,104	1,348,843
Harrisburg, Pa	49	41,930	62	25,805	111	67,735
Hartford, Conn	420	1,437,950	239	248,453	659	1,686,403
Haverhill, Mass	159	462,950	29	62,250	188	525,200
Hoboken, N. J	47	62,417	46	45,340	93	107,757
Holyoke, Mass	55	300,500	15	21,800	70	322,300
Houston, Tex	809	1,159,842	653	162,190	1,462	1,322,032
Indianapolis, Ind	1,844	3,209,687	2,761	801,416	4,605	4,011,103
Jacksonville, Fla	965	1,525,090	183	133,000	1,148	1,658,090
Kalamazoo, Mich	602	1,800,000	1,000	500,000	1,602	2,300,000
Kansas City, Kans	608	156,330	64	109,600	672	265,930
Kansas City, Mo	1,418	4,607,000	1,212	500,190	2,630	5,107,190
Knoxville, Tenn	158	353,054	1,015	62,926	1,173	415,980
Lancaster, Pa						
Lawrence, Mass	288	1,054,630	117	158,740	405	1,213,370
Lincoln, Nebr	330	567,100	66	72,735	396	639,835
Los Angeles, Cal	6,674	11,695,324	3,016	947,343	9,690	12,642,667
Louisville, Ky	1,039	1,177,693	870	177,450	1,909	1,355,143
Lowell, Mass	246	486,496	263	209,863	509	696,359
Lynn, Mass	412	1,411,830	311	184,875	723	1,596,705
Macon, Ga	236	412,570	142	83,622	378	496,192
Malden, Mass	182	500,000	81	133,785	263	633,785
Manchester, N. H	276	721,860	251	246,516	527	968,376
Milwaukee, Wis	1,732	5,140,686	1,776	1,028,474	3,508	6,169,160
Mobile, Ala	146	159,645	44	29,870	190	189,515

a Additions, etc., to all classes of buildings for Atlanta are included with additions to wooden buildings.
b The number of permits for Berkeley were not given, and the additions, etc., to wooden, stone, and concrete buildings are included with the new buildings of each of these classes.
c The number of permits for new wooden buildings and for additions, etc., to wooden and concrete buildings for Dubuque was not given.

Building statistics of the leading cities of the United States, by character of operations, in 1910—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.
Montgomery, Ala	96	$102,500	178	$22,600	274	$125,100
Nashville, Tenn	513	368,085	895	54,586	1,408	422,671
Newark, N. J	2,142	6,277,245			a 2,142	a 6,277,245
New Bedford, Mass	892	2,936,675	237	186,500	1,129	3,123,175
New Britain, Conn	108	431,400	b 257	b 64,162	365	495,562
New Castle, Pa	75	70,000	10	3,000	85	73,000
New Haven, Conn	444	1,536,458	294	138,613	738	1,675,071
Newton, Mass	209	872,317	87	106,450	296	978,767
New York, N. Y	331	1,280,125	336	339,835	667	1,619,960
Norfolk, Va	195	417,828	96	45,980	291	463,808
Oakland, Cal	2,221	4,482,246	1,698	590,481	3,919	5,072,727
Oklahoma City, Okla	1,408	1,915,875	71	68,367	1,479	1,984,242
Omaha, Nebr	959	1,226,148	250	137,325	1,209	1,363,473
Passaic, N. J	265	961,950	96	74,645	361	1,036,595
Paterson, N. J	607	990,706	130	225,000	737	1,215,706
Pawtucket, R. I	199	562,310	138	52,100	337	614,410
Peoria, Ill	292	872,082	511	168,355	803	1,040,437
Philadelphia, Pa	112	262,230	300	123,910	412	386,140
Pittsburgh, Pa	1,405	6,315,664	1,000	900,000	2,405	7,215,664
Portland, Oreg	4,188	7,505,345	1,043	824,622	5,231	8,329,967
Providence, R. I	837	2,819,850	1,303	415,550	2,140	3,235,400
Pueblo, Colo	61	47,930	57	17,112	118	65,042
Quincy, Ill	21	54,300	5	5,100	26	59,400
Reading, Pa						
Richmond, Va	277	304,284	297	83,144	574	387,428
Rochester, N. Y	2,237	5,994,805	762	493,014	2,999	6,487,819
Sacramento, Cal	384	1,836,472	42	34,684	426	1,871,156
Saginaw, Mich	151	135,630	60	25,910	211	161,540
St. Louis, Mo	4,069	1,286,239	1,133	285,047	5,202	1,571,286
St. Paul, Minn	2,293	4,417,977	716	537,660	3,009	4,955,637
Salem, Mass	165	509,680	107	185,500	272	695,180
Salt Lake City, Utah	175	196,400	63	33,700	238	230,100
San Antonio, Tex	2,254	1,611,813	1,012	163,394	3,266	1,775,207
San Diego, Cal	1,347	1,905,165	508	208,620	1,855	2,113,785
San Francisco, Cal	2,417	8,007,152	2,633	871,960	5,050	8,879,112
Savannah, Ga	253	404,500	150	80,000	403	484,500
Schenectady, N. Y	506	1,194,923	261	90,145	767	1,285,068
Scranton, Pa	442	1,225,571	253	181,240	695	1,406,811
Seattle, Wash	5,445	6,618,133	4,617	417,641	10,062	7,035,774
Sioux City, Iowa	286	534,980	58	66,834	344	601,814
Somerville, Mass	319	856,110			319	856,110
South Bend, Ind	512	802,831			512	802,831
Spokane, Wash	1,961	2,861,584	243	116,205	2,204	2,977,789
Springfield, Ill	269	573,560	147	84,000	416	657,560
Springfield, Mass	504	2,101,350	130	155,950	634	2,257,300
Syracuse, N. Y	939	2,860,641	600	600,000	1,539	3,460,641
Tampa, Fla	295	398,722	507	55,571	802	454,293
Terre Haute, Ind	617	593,908	156	111,872	773	705,780
Toledo, Ohio	746	1,308,600	534	169,911	1,280	1,478,511
Topeka, Kans	410	816,392	186	183,610	596	1,000,002
Troy, N. Y	70	247,260	154	83,415	224	330,675
Utica, N. Y	269	798,170	232	125,399	501	923,569
Washington, D. C	864	2,460,173	1,128	132,644	1,992	2,592,817
Wheeling, W. Va	119	142,347	336	45,472	455	187,819
Wichita, Kans	868	1,563,251	97	31,680	965	1,594,931
Wilkes-Barre, Pa	370	749,495	202	153,577	572	903,072
Wilmington, Del						
Woonsocket, R. I	160	405,000	65	7,000	225	412,000
Worcester, Mass	838	2,345,582	524	280,523	1,362	2,626,105
Yonkers, N. Y	374	1,510,670	67	49,310	441	1,559,980
York, Pa	21	42,000	75	18,000	96	60,000
Youngstown, Ohio	820	1,307,125	228	200,341	1,048	1,507,466
Total	97,690	202,614,030	67,922	27,570,759	165,689	230,184,789
Per cent of total		23.72		3.23		26.95

a Additions, etc., for all buildings for Newark are included with new buildings.
b Additions, etc., to brick buildings for New Britain are included with additions to wooden buildings.

Building statistics of the leading cities of the United States, by character of operations, in 1910—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.
Allentown, Pa	149	$1,347,050	73	$104,700	3	$119,000		
Altoona, Pa	25	201,142	7	75,301				
Atlanta, Ga	182	1,275,346						
Augusta, Ga	102	257,145	302	24,606				
Baltimore, Md	a 2,127	a 10,412,303	a 552	a 556,007				
Bay City, Mich	11	135,500	5	8,750				
Bayonne, N. J	41	155,150						
Berkeley, Cal					(b)	b 1,492,316		(b)
Binghamton, N. Y	30	289,050	2	40,000				
Birmingham, Ala	68	929,389	10	95,050				
Boston, Mass	320	5,857,647	1,132	3,532,286	2	30,200	31	$184,785
Bridgeport, Conn	294	1,137,434						
Brockton, Mass	4	314,000			1	100,000		
Brooklyn, N. Y	a 4,106	a 30,029,005	a 1,821	a 3,275,453				
Buffalo, N. Y	204	1,663,900	46	268,910	6	113,000		
Cambridge, Mass	23	580,200	21	43,375	1	200,000		
Camden, N. J	523	1,041,800	86	66,200			1	4,000
Canton, Ohio	5	15,000						
Charleston, S. C	19	381,465	82	125,299				
Chester, Pa	230	540,500	27	13,500	1	6,000		
Chicago, Ill	6,785	60,418,000	3,940	1,770,000	257	20,326,400		
Cincinnati, Ohio	697	5,175,800	c 1,750	c 555,795				
Cleveland, Ohio	569	7,016,842	399	1,126,844			88	25,178
Dallas, Tex	99	996,698	100	150,000				
Davenport, Iowa	30	941,500	12	55,000				
Denver, Colo	2,013	7,694,785	460	667,195				
Des Moines, Iowa	106	550,000	4	12,000				
Detroit, Mich	502	6,662,510	258	1,213,360				
Dubuque, Iowa	30	1,363,000	8	72,500			4	4,500
Duluth, Minn	78	675,950	94	226,045				
East St. Louis, Ill	135	753,735	10	11,768				
Elizabeth, N. J	48	361,649	29	42,176				
Elmira, N. Y	7	302,400						
El Paso, Tex	263	887,457	50	77,701				
Erie, Pa	d 130	d 910,485	d 106	d 102,980	(d)	(d)	(d)	(d)
Evansville, Ind	71	409,334	112	110,142	2	24,000		
Fall River, Mass	12	171,450	8	93,975	3	41,000		
Fitchburg, Mass	15	336,250			4	18,500		
Fort Wayne, Ind	30	461,600	68	112,180				
Galveston, Tex	4	11,100	7	7,365				
Grand Rapids, Mich	56	551,948	61	203,295				
Harrisburg, Pa	346	818,350	98	190,230	6	60,800		
Hartford, Conn	275	2,689,346	119	166,230				
Haverhill, Mass	7	122,650	18	89,300				
Hoboken, N. J	41	662,206	51	127,987				
Holyoke, Mass	45	1,778,500	44	99,500	2	7,500		
Houston, Tex	27	499,150	90	92,945				
Indianapolis, Ind	82	585,128	288	685,625				
Jacksonville, Fla	85	1,179,850	26	96,000				
Kalamazoo, Mich	100	500,000	50	100,000			1	75,000
Kansas City, Kans	67	41,200	5	7,000	3	212,500	1	1,600
Kansas City, Mo	393	7,135,900	95	11,500	19	325,100	2	5,000
Knoxville, Tenn	35	339,708	208	31,436				
Lancaster, Pa	335	929,500	348	174,000				
Lawrence, Mass	23	3,635,000	26	135,250				
Lincoln, Nebr	20	269,175	13	24,500			2	2,100
Los Angeles, Cal	281	3,712,059	734	802,236				
Louisville, Ky	175	2,249,954	384	391,695				
Lowell, Mass	18	785,000	34	96,295				
Lynn, Mass	15	510,900	13	66,700				
Macon, Ga	20	233,532	19	20,428				
Malden, Mass	9	130,000	12	68,000				
Manchester, N. H	9	283,500	1	58,250			2	23,750
Milwaukee, Wis	152	2,129,260	350	500,000				

a All classes of new fire-resisting buildings for Baltimore and Brooklyn are included with new brick buildings, and additions to all classes of fire-resisting buildings are included with additions to brick buildings.

b The number of permits for Berkeley was not given, and the additions, etc., to wooden, stone, and concrete buildings are included with the new buildings of each of these classes.

c In additions, etc., to brick buildings for Cincinnati are included 1,179 permits for unclassified additions costing $157,920.

d New stone buildings for Erie are included with new brick buildings, and additions etc., to stone buildings are included with additions to brick buildings.

Building statistics of the leading cities of the United States, by character of operations, in 1910—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.
Mobile, Ala	21	$219,554	40	$32,070				
Montgomery, Ala	15	111,500	12	40,900				
Nashville, Tenn	320	1,069,315	282	49,959				
Newark, N. J	684	4,324,936			3	(a)		
New Bedford, Mass	b 50	b 3,914,162	(b)	(b)				
New Britain, Conn	58	509,000	(c)	(c)				
New Castle, Pa	40	70,000			2	$22,000		
New Haven, Conn	148	1,824,075	134	364,844	2	350,000		
Newton, Mass	8	284,300	1	3,120	3	278,000		
New York, N. Y	2,427	120,312,409	3,459	11,235,186	62	6,754,300	31	$277,850
Norfolk, Va	206	1,081,793	44	45,147				
Oakland, Cal	9	1,219,509	13	345,250				
Oklahoma City, Okla								
Omaha, Nebr	220	4,628,700	104	258,815				
Passaic, N. J	83	814,500	52	161,192				
Paterson, N. J	115	805,458	23	161,091	4	3,884		
Pawtucket, R. I	14	238,200	7	56,700				
Peoria, Ill	55	481,624	179	192,616				
Philadelphia, Pa	9,706	27,942,875	4,958	6,200,000	10	150,000	170	95,000
Pittsburgh, Pa	860	3,885,000	410	369,000	48	44,000		
Portland, Oreg	211	5,854,547	878	374,363	12	750,000	5	185,000
Providence, R. I	77	1,292,100	89	407,800				
Pueblo, Colo	56	356,576	21	24,515				
Quincy, Ill	39	324,900	9	23,400	4	28,000	1	100,000
Reading, Pa	287	618,555			44	245,500		
Richmond, Va	471	2,302,365	343	331,029	2	724,000		
Rochester, N. Y	93	1,120,613	173	352,728	1	20,000		
Sacramento, Cal	6	346,200	5	15,950				
Saginaw, Mich	27	116,900	9	51,250				
St. Louis, Mo	2,737	13,345,257	1,162	1,325,642				
St. Paul, Minn	494	2,848,793	234	782,701	13	135,690	3	31,300
Salem, Mass	12	309,650	4	22,450				
Salt Lake City, Utah	608	3,924,300	147	307,200				
San Antonio, Tex	64	414,350	108	174,825				
San Diego, Cal	34	587,505						
San Francisco, Cal	250	7,060,350	d 350	d 403,094	23	3,380,000	(d)	(d)
Savannah, Ga	26	75,000	67	106,420				
Schenectady, N. Y	60	458,025	49	172,120				
Scranton, Pa	50	448,817	59	174,415				
Seattle, Wash	59	2,730,900	2,863	658,765	1	145,000		
Sioux City, Iowa	17	475,374	17	83,094			4	3,000
Somerville, Mass	19	74,750						
South Bend, Ind	36	336,476						
Spokane, Wash	191	2,615,985	129	289,710				
Springfield, Ill	37	206,450	46	73,900				
Springfield, Mass	113	2,459,700	50	538,725	3	387,500	1	150,000
Syracuse, N. Y	51	797,287	40	143,216				
Tampa, Fla	42	143,839	126	13,893	10	5,753		
Terre Haute, Ind	34	127,150	18	51,750				
Toledo, Ohio	86	1,084,339	148	238,400	3	148,000		
Topeka, Kans	56	126,660	5	5,600	14	73,030	3	3,000
Troy, N. Y	43	213,200	129	162,980				
Utica, N. Y	38	431,950	25	55,325				
Washington, D. C	e 1,710	e 11,817,171	2,144	1,858,670				
Wheeling, W. Va	37	466,270	287	235,788			9	11,565
Wichita, Kans	118	1,378,000	41	22,470				
Wilkes-Barre, Pa	98	823,828	90	285,280				
Wilmington, Del	598	1,354,269	147	246,978				
Woonsocket, R. I	16	100,000						
Worcester, Mass	43	819,845	94	259,677	2	69,000		
Yonkers, N. Y	125	1,573,075	70	178,700	10	75,800	2	38,000
York, Pa	213	639,000	259	47,000				
Youngstown, Ohio	f 209	f 761,005			(f)	(f)		
Total	47,333	431,533,563	34,821	48,890,578	586	36,865,773	361	1,220,628
Per cent of total		50.53		5.72		4.32		.14

a Additions, etc., for all buildings for Newark are included with new buildings and the cost of new stone buildings is included with the cost of new concrete buildings.
b Additions, etc., to brick buildings for New Bedford are included with new brick buildings.
c Additions, etc., to brick buildings for New Britain are included with additions to wooden buildings.
d Additions, etc., to stone and concrete buildings for San Francisco are included with additions to brick buildings.
e All other new fire-resisting buildings for Washington are included with new brick buildings.
f New stone buildings for Youngstown are included with new brick buildings.

Building statistics of the principal cities of the United States, by character of operations, in 1910—Continued.

City.	Fire-resisting buildings—Continued.							
	Concrete.				All other.			
	New.		Additional alterations and repairs.		New.		Additional 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	10	$8,700						
Altoona, Pa	1	7,000						
Atlanta, Ga	20	606,000			3	$1,000,000		
Bay City, Mich	1	1,300					1	$200
Bayonne, N. J	17	308,332						
Berkeley, Cal	(a)	a 55,822		(a)				
Binghampton, N. Y	16	44,015						
Birmingham, Ala	3	26.000						
Boston, Mass	30	1,031,443	14	$42,700	33	4,025,100	33	360,075
Bridgeport, Conn	90	284,358			33	71,089		
Buffalo, N. Y	6	380,000			169	1,680,640		
Cambridge, Mass	14	483,500						
Camden, N. J	6	157,000						
Canton, Ohio	10	60,000						
Chester, Pa	1	3,000						
Chicago, Ill	542	6,626,000	120	60,000				
Cincinnati, Ohio	14	226,975						
Cleveland, Ohio	103	439,385			9	24,123	121	32,172
Dallas, Tex					13	1,189,000		
Davenport, Iowa	1	60,000						
Denver, Colo	49	169,000	1	9,000	8	2,668,000		
Des Moines, Iowa	1	20,000					7	9,000
Detroit, Mich	38	1,209,500	2	38,000				
Dubuque, Iowa	1	50,000	(b)	3,000				
Duluth, Minn					20	10,962,250		
East St. Louis, Ill	1	15,000						
Elizabeth, N. J	13	5,865			3	33,466		
Elmira, N. Y	12	379,600			5	12,000		
El Paso, Tex	14	801.720						
Evansville, Ind	6	392,500						
Fall River, Mass					18	324,029		
Fitchburg, Mass	3	47,000						
Fort Wayne, Ind	2	16,000			6	22,500		
Galveston, Tex							2	3,800
Grand Rapids, Mich	41	147,335	6	4,200				
Harrisburg, Pa					4	2,200		
Haverhill, Mass					3	14,700		
Hoboken, N. J	7	53,830	1	1,000	1	1,000		
Holyoke, Mass	1	4,000	1	40,000	1	10,000		
Houston, Tex	14	889,365			3	1,112,868		
Indianapolis, Ind	62	617,610			75	2,294,845		
Jacksonville, Fla	9	251,000						
Kalamazoo, Mich	5	1,000,000	5	100,000	2	50,000	8	100,000
Kansas City, Kans	1	65,000	3	38,000	41	370,126	7	100,000
Kansas City, Mo	8	235,000						
Lawrence, Mass	5	42,600						
Lincoln, Nebr	6	37,500			c 12	18,250	(c)	405,850
Los Angeles, Cal	24	1,781,421	1	125,000	8	2,620,717		
Lowell, Mass	1	200,000						
Lynn, Mass	7	43,200	1	125,000				
Macon, Ga	3	278,800			2	760		
Manchester, N. H	2	654						
Milwaukee, Wis	71	965,710			5	33,450		
Newark, N. J	90	d 586,631			82	2,206,000		
New Castle, Pa	8	2,000						
New Haven, Conn	11	21,375			2	150,700		

[a] The number of permits for Berkley was not given, and the additions, etc., to concrete buildings are included with the new concrete buildings.
[b] The number of permits for new wooden buildings and for additions, etc., to wooden and concrete buildings for Dubuque was not given.
[c] The number of permits for additions, etc., to all other fire-resisting buildings for Lincoln is included with those for all other new fire-resisting buildings.
[d] Additions, etc., for all buildings for Newark are included with new buildings and the cost of new stone buildings is included with the cost of new concrete buildings.

Building statistics of the principal cities of the United States, by character of operations, in 1910—Continued.

City.	Fire-resisting buildings—Continued.							
	Concrete.				All other.			
	New.		Additional alterations and repairs.		New.		Additional 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.
Newton, Mass	6	$36,300			19	$64,000		
New York, N. Y					44	12,390,600	187	$1,485,320
Norfolk, Va	2	36,500	1	$150			18	3,911
Oakland, Cal	9	194,869	6	47,644	10	25,894	2	7,750
Paterson, N. J	17	19,277						
Peoria, Ill	12	29,480			5	552,200		
Philadelphia, Pa	28	2,100,000	75	300,000	35	42,800	989	649,750
Pittsburgh, Pa	24	172,000			139	940,000	17	128,000
Portland, Oreg	160	3,670,000	22	18,325	3	1,701,000	1	3,000
Pueblo, Colo	2	2,150						
Quincy, Ill	7	182,700						
Reading, Pa	11	10,000			69	180,500		
Richmond, Va	7	268,000						
Rochester, N. Y	95	342,768	47	46,448	40	1,703,262	8	8,890
Sacramento, Cal	4	93,300						
Saginaw, Mich	4	26,300			5	105,000		
St. Louis, Mo	176	3,103,138	142	254,740				
St. Paul, Minn	50	1,084,392	3	82,293			3	132,200
Salem, Mass	1	4,000						
San Antonio, Tex	11	39,000			29	487,725		
San Diego, Cal	14	1,229,900						
San Francisco, Cal	17	786,000	(a)	(a)				
Savannah, Ga	21	97,500						
Scranton, Pa							90	55,905
Seattle, Wash	24	2,062,400	12	275,425	7	3,809,000	54	700,814
South Bend, Ind	16	69,560						
Springfield, Ill	2	363,000						
Springfield, Mass	3	175,250						
Syracuse, N. Y	67	577,888	4	40,000				
Tampa, Fla	21	170,881						
Terre Haute, Ind	35	23,115	2	1,050				
Toledo, Ohio	12	672,000			152	238,400	51	198,538
Topeka, Kans	4	318,000						
Troy, N. Y	2	10,600			6	336,000		
Utica, N. Y	11	21,470	2	4,000	12	991,525	7	24,750
Washington, D. C	1	10,000			(b)	(b)		
Wichita, Kans	6	560,000			8	717,000		
Wilkes-Barre, Pa	2	40,000						
Wilmington, Del					5	489,581		
Woonsocket, R. I	4	2,600						
Worcester, Mass	7	125,675	2	17,000	1	1,800	3	550
Yonkers, N. Y	23	87,700			12	58,800		
York, Pa	2	4,000						
Total	2,321	39,959,759	473	1,672,975	1,162	55,732,900	1,609	4,410,475
Per cent of total		4.68		.20		6.53		.52

[a] Additions, etc., to concrete buildings for San Francisco are included with additions to brick buildings.
[b] All other new fire-resisting buildings for Washington are included with new brick buildings.

Building statistics of the principal cities of the United States, by character of operations, in 1910—Continued.

City.	Fire-resisting buildings—Continued. Total.		Grand total.		Rank of cities in cost of buildings erected.
	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	
Allentown, Pa	235	$1,579,450	317	$1,623,700	88
Altoona, Pa	33	283,443	757	750,955	132
Atlanta, Ga	205	2,881,346	4,001	6,645,167	30
Augusta, Ga	404	281,751	1,340	439,216	141
Baltimore, Md	2,679	10,968,310	2,841	11,771,680	19
Bay City, Mich	18	145,750	114	234,825	143
Bayonne, N. J	58	463,482	536	1,707,387	84
Berkeley, Cal	(a)	1,548,138	(a)	3,035,128	57
Binghamton, N. Y	48	373,065	652	964,543	116
Birmingham, Ala	81	1,050,439	2,467	3,537,592	54
Boston, Mass	1,595	15,064,236	3,608	20,869,671	7
Bridgeport, Conn	417	1,492,881	907	2,274,868	68
Brockton, Mass	5	414,000	499	1,507,535	93
Brooklyn, N. Y	5,927	33,304,458	9,892	39,233,098	3
Buffalo, N. Y	431	4,106,450	3,494	9,232,000	24
Cambridge, Mass	59	1,307,075	389	2,339,900	65
Camden, N. J	616	1,269,000	994	1,449,900	95
Canton, Ohio	15	75,000	644	854,345	124
Charleston, S. C	101	506,764	542	796,667	127
Chester, Pa	259	563,000	268	568,000	136
Chicago, Ill	11,644	89,290,400	23,255	101,098,700	2
Cincinnati, Ohio	2,461	5,958,570	4,050	8.052,870	26
Cleveland, Ohio	1,289	8,664,544	7,460	13,948,413	14
Dallas, Tex	212	2.335,698	1,759	4,198,050	46
Davenport, Iowa	43	1,056,500	184	1,611,429	89
Denver, Colo	2,531	11,207,980	2,683	11,319,955	20
Des Moines, Iowa	118	591,000	606	1,339,187	99
Detroit, Mich	800	9,123.370	5,498	17,415,950	11
Dubuque, Iowa	43	1,493.000	120	1,746,000	83
Duluth, Minn	192	11,864,245	1,458	13,311.964	16
East St. Louis, Ill	146	780,503	544	1,313,178	103
Elizabeth, N. J	93	443,156	536	1,504,106	94
Elmira, N. Y	24	694,000	114	916,300	119
El Paso, Tex	327	1.766,878	327	1,766,878	82
Erie, Pa	236	1,013,465	969	1,893,990	80
Evansville, Ind	191	935,976	1,032	1.317,010	102
Fall River, Mass	41	630,454	469	1,544,129	90
Fitchburg, Mass	22	401,750	256	867,740	123
Fort Wayne, Ind	106	612,280	744	1,626,245	87
Galveston, Tex	13	22,265	165	125,890	145
Grand Rapids, Mich	164	906.778	1,268	2,255,621	71
Harrisburg, Pa	454	1,071,580	565	1,139,315	107
Hartford, Conn	394	2,855,576	1,053	4,541,979	40
Haverhill, Mass	28	226,650	216	751,850	131
Hoboken, N. J	101	846,023	194	953,780	117
Holyoke, Mass	94	1,939,560	164	2,261,800	70
Houston, Tex	134	2,594.328	1,596	3,916,360	52
Indianapolis, Ind	507	4,183,208	5,112	8,194,311	25
Jacksonville, Fla	120	1,526,850	1,268	3,184,940	56
Kalamazoo, Mich	171	1,925.000	1,773	4,225,000	45
Kansas City, Kans	128	835,426	800	1,101,356	110
Kansas City, Mo	517	7,712,500	3,147	12,819,690	17
Knoxville, Tenn	243	371,144	1,416	787,124	129
Lancaster, Pa	683	1,103,500	683	1,103,500	109
Lawrence, Mass	54	3,812,850	459	5,026,220	37
Lincoln, Nebr	53	757,375	449	1,397,210	97
Los Angeles, Cal	1,048	9,041,433	10,738	21,684,100	5
Louisville, Ky	559	2,641,649	2,468	3,996,792	49
Lowell, Mass	53	1,081,295	562	1,777.654	81
Lynn, Mass	36	745,800	759	2,342,505	64
Macon, Ga	44	533,520	422	1,029,712	114
Maldin, Mass	21	198,000	284	831,785	126
Manchester, N. H	14	366,154	541	1,334,530	100
Milwaukee, Wis	578	3,628,420	4,086	9,797,580	23
Mobile, Ala	61	251,624	251	441,139	140
Montgomery, Ala	27	152,400	301	277,500	142

a The number of permits for Berkeley was not given, and the additions, etc., to wooden, stone, and concrete buildings are included with the new buildings of each of these classes.

Building statistics of the principal cities of the United States, by character of operations, in 1910—Continued.

Cities.	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.
Nashville, Tenn	602	$1,119,274	2,010	$1,541,945	91
Newark, N. J	859	7,117,567	3,001	13,394,812	15
New Bedford, Mass	50	3,914,162	1,179	7,037,337	27
New Britain, Conn	58	509,000	423	1,004,562	115
New Castle, Pa	50	94,000	135	167,000	144
New Haven, Conn	297	2,710,994	1,035	4,386,065	43
Newton, Mass	37	665,720	333	1,644,487	85
New York, N. Y	6,210	152,455,665	6,877	154,075,625	1
Norfolk, Va	271	1,167,501	562	1,631,309	86
Oakland, Cal	49	1,840,916	3,968	6,913,643	29
Oklahoma City, Okla	[a] 211	[a] 3,508,961	1,690	5,493,203	35
Omaha, Nebr	324	4,887,515	1,533	6,250,988	32
Passaic, N. J	135	975,692	496	2,012,287	78
Paterson, N. J	159	989,710	896	2,205,416	72
Pawtucket, R. I	21	294,900	358	909,310	120
Peoria, Ill	251	1,255,920	1,054	2,296,357	67
Philadelphia, Pa	15,971	37,480,425	16,383	37,866,565	4
Pittsburgh, Pa	1,498	5,538,000	3,903	12,753,664	18
Portland, Oreg	1,292	12,556,235	6,523	20,886,202	6
Providence, R. I	166	1,699,900	2,306	4,935,300	39
Pueblo, Colo	79	383,241	197	448,283	139
Quincy, Ill	60	659,000	86	718,400	134
Reading, Pa	411	1,054,555	411	1,054,555	111
Richmond, Va	823	3,625,394	1,397	4,012,822	48
Rochester, N. Y	457	3,594,709	3,456	10,082,528	21
Sacramento, Cal	15	455,450	441	2,326,606	66
Saginaw, Mich	45	299,450	256	460,990	138
St. Louis, Mo	4,217	18,028,777	9,419	19,600,063	9
St. Paul, Minn	800	5,097,369	3,809	10,053,006	22
Salem, Mass	17	336,100	289	1,031,280	113
Salt Lake City, Utah	755	4,231,560	993	4,461,600	42
San Antonio, Tex	212	1,115,900	3,478	2,891,107	59
San Diego, Cal	48	1,817,405	1,903	3,931,190	50
San Francisco, Cal	640	11,629,444	5,690	20,508,556	8
Savannah, Ga	114	278,920	517	763,420	130
Schenectady, N. Y	109	630,145	876	1,915,213	79
Scranton, Pa	199	679,137	894	2,085,948	75
Seattle, Wash	3,020	10,382,304	13,082	17,418,078	10
Sioux City, Iowa	38	561,468	382	1,163,282	106
Somerville, Mass	19	74,750	338	930,860	118
South Bend, Ind	52	406,036	564	1,208,867	105
Spokane, Wash	320	2,905,695	2,524	5,883,484	34
Springfield, Ill	85	643,350	501	1,300,910	104
Springfield, Mass	170	3,711,175	804	5,968,475	33
Syracuse, N. Y	162	1,558,391	1,701	5,019,032	38
Tampa, Fla	199	334,366	1,001	788,659	128
Terre Haute, Ind	89	203,065	862	908,845	121
Toledo, Ohio	452	2,579,677	1,732	4,058,188	47
Topeka, Kans	82	526,230	678	1,526,232	92
Troy, N. Y	180	722,780	404	1,053,455	112
Utica, N. Y	95	1,529,020	596	2,452,589	63
Washington, D. C	3,855	13,685,841	5,847	16,278,658	12
Wheeling, W. Va	333	713,623	788	901,442	122
Wichita, Kans	173	2,677,470	1,138	4,272,401	44
Wilkes-Barre, Pa	190	1,149,108	762	2,052,180	76
Wilmington, Del	750	2,090,828	750	2,090,828	74
Woonsocket, R. I	20	102,600	245	514,600	137
Worcester, Mass	152	1,293,547	1,514	3,919,652	51
Yonkers, N. Y	242	2,012,075	683	3,572,055	53
York, Pa	474	690,000	570	750,000	133
Youngstown, Ohio	209	761,005	1,257	2,268,471	69
Total	88,877	623,795,612	254,566	853,980,401	....
Per cent of total	....	[a] 73.05	....	100.00	....

[a] The total only was given for fire-resisting buildings for Oklahoma City. The percentage for this total, equivalent to $\frac{41}{100}$ of 1 per cent, is included in the percentage for total fire-resisting buildings.

Building statistics of the principal cities of the United States, by character of operations, in 1910—Continued.

Cities.	Grand total.		Rank of cities in cost of buildings erected.
	Number of permits or buildings.	Cost.	
Albany, N. Y	587	$3,025,500	58
Atlantic City, N. J	1,435	3,300,483	55
Butte, Mont	187	833,793	125
Chattanooga, Tenn	1,270	1,324,464	101
Columbus, Ohio	2,363	5,133,591	36
Dayton, Ohio	1,082	2,015,000	77
Jersey City, N. J	1,522	6,932,570	28
Little Rock, Ark	886	1,384,423	98
Memphis, Tenn	3,419	6,280,498	31
Minneapolis, Minn	6,225	14,363,830	13
New Orleans, La	2,530	4,483,730	41
Portland, Me	410	1,438,595	96
Rockford, Ill	([a])	2,642,078	61
St. Joseph, Mo	772	1,129,931	108
Superior, Wis	196	697,227	135
Tacoma, Wash	3,074	2,685,051	60
Trenton, N. J	1,389	2,125,710	73
Waterbury, Conn	748	2,576,900	62
Grand total	282,661	916,353,775	....

[a] The number of permits was not given for Rockford.

This table shows that the 145 cities included reported for 1910 building operations costing $916,353,775. Of these cities 127 reported sufficient detail to permit the publication of statistics of building operations by classes of structures. These 127 cities reported 254,566 permits or buildings, work on which cost $853,980,401. Of this total new buildings constituted 89.78 per cent, and additions, alterations, and repairs, 9.81 per cent, 0.41 per cent being fire-resisting buildings not separately classified.

Taken by classes the new wooden buildings constituted 23.72 per cent of the total cost, and the additions, alterations, and repairs to wooden buildings 3.23 per cent; new brick buildings, 50.53 per cent, additions, etc., 5.72 per cent; new stone buildings, 4.32 per cent, additions, etc., 0.14 per cent; new concrete buildings, 4.68 per cent, additions, etc., 0.20 per cent; all other fire-resisting buildings, 6.53 per cent, additions, 0.52 per cent. Of the cost of new buildings 73.57 per cent was fire-resisting and 26.43 per cent was wooden buildings. Of the cost of all new fire-resisting buildings 76.50 per cent was for brick buildings, 6.54 per cent for stone buildings, 7.08 per cent for concrete buildings, and 9.88 per cent for all other fire-resisting buildings. Of the cost of additions, alterations, and repairs, 32.91 per cent was for wooden buildings and 67.09 per cent was for fire-resisting buildings. Of the last item 87 per cent was for brick buildings, 2.17 per cent for stone buildings, 2.98 per cent for concrete buildings, and 7.85 per cent for all other fire-resisting buildings.

Operations on brick buildings (new buildings, additions, alterations, and repairs) constituted 56.25 per cent of the entire cost of all operations in these 127 cities, all other fire-resisting buildings contributing but 16.39 per cent. In addition to the brick used in brick buildings large quantities of brick were used as foundations to wooden buildings and in the construction of all other fire-resisting buildings.

The average cost in 1910 of new wooden buildings was $2,074; of new brick buildings, $9,117; of new stone buildings, $62,911; of new concrete buildings, $17,217; and of miscellaneous fire-resisting buildings, $47,963.

Wooden buildings.—Los Angeles reported the largest number of new wooden buildings, 6,674, with an average cost of $1,752. Seattle was second, reporting 5,445 buildings, with an average cost of $1,215. In 1909, Seattle reported the largest number of new wooden buildings, 7,355, with an average cost of $1,338 each, and Los Angeles was second, reporting 5,284 buildings, with an average cost of $1,553 each. There was therefore a decrease of 1,910 buildings in Seattle and an increase of 1,390 new buildings in Los Angeles.

Los Angeles was the leading city in the cost of wooden buildings in 1910, reporting a total cost of $11,695,324. Chicago, which was the leading city in cost of wooden buildings in 1909, was second in 1910, reporting a total cost for this class of buildings of $9,562,500, or an average of $2,500 each. In 1909 these figures were $13,532,880 and $4,912, respectively. San Francisco, which was second in 1909, was third in 1910, reporting 2,417 new wooden buildings costing $8,007,-152, or an average of $3,313. In 1909 the value of this class of buildings in San Francisco was $12,257,683, with an average cost of $4,186. Four cities reported no operations on wooden buildings, namely, El Paso, Tex., Lancaster, Pa., Reading, Pa., and Wilmington, Del.

Fire-resisting buildings.—New York reported the construction of fire-resisting buildings at a cost of $152,455,665, or 24.44 per cent of the total for this class of buildings; this was a decrease of $29,462,672, or 16.20 per cent, from 1909. Chicago was second, as in 1909, with a cost of $89,200,400, or 14.30 per cent; this was an increase over 1909 of $10,094,900, or 12.76 per cent. Brooklyn, which was third in cost of fire-resisting buildings in 1909, was fourth in 1910, being displaced by Philadelphia, which reported for 1910 a cost for this class of buildings of $37,480,425, or 6.01 per cent of the total; this was a decrease from 1909 of $5,090,345, or 11.96 per cent. Brooklyn reported buildings of this class costing $33,304,458, or 5.34 per cent of the total; this was a loss of $21,354,263, or 39.07 per cent. St. Louis was fifth, with a cost of $18,028,777, or 2.89 per cent of the total, which was a decrease of $4,394,152, or 19.60 per cent. Boston was sixth, with a cost of $15,064,236, or 2.41 per cent of the total, which was an increase of $5,286,242, or 54.06 per cent. Washington was seventh in cost of fire-resisting buildings, reporting a cost of $13,685,841, or 2.19 per cent of the total; this was an increase of $1,404,836, or 11.44 per cent. Portland, Oreg., was eighth in cost of fire-resisting buildings in 1910 and eighteenth in 1909. San Francisco, which was sixth in 1909, was tenth in 1910; Denver was eighth in 1909 and eleventh in 1910; Baltimore was tenth in 1909 and twelfth in 1910; and Seattle was fourteenth in 1909 and thirteenth in 1910. Of these leading cities in the cost of fire-resisting buildings, Duluth made the greatest proportionate gain—385.77 per cent, or from $2,442,344 in 1909 to $11,864,245 in 1910.

As explained elsewhere, the figures for the several classes of buildings, except for wooden buildings and for the total for fire-resisting buildings, are not exact for the reason that for some of the cities it has been impossible to report the several classes separately. As the figures stand, New York was the leading city in new brick buildings, and reported a cost of $120,312,409, or an average of $49,572 per building; in 1909 the cost of new brick buildings in New York was $151,832,438, or an average of $60,395. Chicago was second, with a cost of $60,418,000, an average cost of $8,905; in 1909 Chicago was third, with a total of $51,145,400, an average of $8,581. In 1910 Brooklyn was third, with $30,029,005, an average of $7,313, compared with $51,747,760 in 1909. Philadelphia was fourth, with $27,942,875, an average of $2,879, compared with $30,653,580, or an average of $2,956 in 1909. In the number of brick buildings, assuming that one permit is issued for each building, Philadelphia was first, as in 1909, reporting 9,706 permits, as compared with 10,370 in 1909; Chicago was second, with 6,785, and Brooklyn third, with 4,106.

In stone buildings, Chicago was the leading city, reporting 43.86 per cent of buildings erected and 55.14 per cent of the total cost of these buildings, with an average cost of $79,091; New York was second, with an average cost of $108,940; San Francisco was third, with an average cost of $146,957. These three cities reported 82.63 per cent of the cost of all the stone buildings in these 127 cities.

The leading city in the number and cost of concrete buildings in 1910 was Chicago, as in 1909, this city reporting 542 buildings, costing $6,626,000, as compared with 519 buildings in 1909, costing $9,894,800. The city ranking second in cost of concrete buildings in 1910 was Portland, Oreg., which reported $3,670,000, followed by St. Louis, with $3,103,138. Of the 127 cities reporting, 90 report 2,321 new concrete buildings; in 1909, of 128 cities, 79 reported new concrete buildings.

Miscellaneous fire-resisting buildings, which include steel-skeleton buildings, were reported from 45 cities for 1910. New York was the leading city in this class of construction, reporting a cost of $12,390,600, with Duluth, Minn., second, with a cost of $10,962,250.

SURVEY PUBLICATIONS ON CLAYS, FULLER'S EARTH, ETC.

In addition to the papers named below, some of the Survey publications listed under the heading "Cement and concrete materials" contain references to clays. Certain of the geologic folios also contain references to clays, fuller's earth, etc.

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.

Alden, W. C. Fuller's earth and brick clays near Clinton, Mass. In Bulletin 430, pp. 402–404. 1910.

Ashley, G. H. Notes on clays and shales in central Pennsylvania. In Bulletin 285, pp. 442–444. 1906.

Ashley, H. E. The colloid matter of clay and its measurement. Bulletin 388. 65 pp. 1909.

Bastin, E. S. Clays of the Penobscot Bay region, Maine. In Bulletin 285, pp. 428–431. 1906.

Branner, J. C. Bibliography of clays and the ceramic arts. Bulletin 143. 114 pp. 1896. 15c.

——— The clays of Arkansas. Bulletin 351. 247 pp. 1908.

Butts, Charles. Clays of the Birmingham district, Alabama. In Bulletin 315, pp. 291–295. 1907. 50c.

Crider, A. F. Clays of western Kentucky and Tennessee. In Bulletin 285, pp. 417–427. 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. 106 pp. 1909.

Darton, N. H., and Siebenthal, C. E. Geology and mineral resources of the Laramie Basin, Wyoming; a preliminary report. Bulletin 364. 81 pp. 1909.

Deussen, Alexander. Notes on some clays from Texas. In Bulletin 470.

Eckel, C. E. Stoneware and brick clays of western Tennessee and northwestern Mississippi. In Bulletin 213, pp. 382–391. 1903. 25c.

——— Clays of Garland County, Ark. In Bulletin 285, pp. 407–411. 1906.

Fenneman, N. M. Clay resources of the St. Louis district, Missouri. In Bulletin 315, pp. 315–321. 1907. 50c.

Fisher, C. A. The bentonite deposits of Wyoming. In Bulletin 260, pp. 559–563. 1905. 40c.

——— Clays in the Kootenai formation near Belt, Mont. In Bulletin 340, pp. 417–423. 1908.

Fuller, M. L. Clays of Cape Cod, Massachusetts. In Bulletin 285, pp. 432–441. 1906.

Landes, Henry. The clay deposits of Washington. In Bulletin 260, pp. 550–558. 1905. 40c.

Lines, E. F. Clays and shales of the Clarion quadrangle, Clarion County, Pa. In Bulletin 315, pp. 335–343. 1907. 50c.

Matson, G. C. Notes on the clays of Florida. In Bulletin 380, pp. 346–356. 1909.

Middleton, Jefferson. Clay-working industries. In Mineral Resources U. S. for 1909, pt. 2, pp. 453–517. 1911.[1]

Phalen, W. C. Clay resources of northeastern Kentucky. In Bulletin 285, pp. 412–416. 1906.

——— Economic geology of the Kenova quadrangle, Kentucky, Ohio, and West Virginia. In Bulletin 349, pp. 112–122. 1908.

Phalen, W. C., and Martin, Lawrence. Mineral resources of Johnstown, Pa., and vicinity. Bulletin 447. 140 pp. 1911.

——— ——— Clays and shales of southwestern Cambria County, Pa. In Bulletin 315, pp. 344–354. 1907. 50c.

Porter, J. T. Properties and tests of fuller's earth. In Bulletin 315, pp. 268–290. 1907. 50c.

[1] Previous volumes of the Mineral Resources of United States contain chapters devoted to clay and the clay-working industries of the United States.

Richardson, G. B. Clay near Calhan, El Paso County, Colo. In Bulletin 470.
Ries, H. Technology of the clay industry. In Sixteenth Ann. Rept., pt. 4, pp. 523–575. 1895. $1.20.
——— The pottery industry of the United States. In Seventeenth Ann. Rept., pt. 3, pp. 842–880. 1896.
——— The clays of the United States east of the Mississippi River. Professional Paper 11. 298 pp. 1903. $1.35.
Schrader, F. C., and Haworth, E. Clay industries of the Independence quadrangle, Kansas. In Bulletin 260, pp. 546–549. 1905. 40c.
Shaler, M. K., and Gardner, J. H. Clay deposits of the western part of the Durango-Gallup coal field of Colorado and New Mexico. In Bulletin 315, pp. 296–302. 1907. 50c.
Shaler, N. S., Woodworth, J. B., and Marbut, C. F. The glacial brick clays of Rhode Island and southeastern Massachusetts. In Seventeenth Ann. Rept., pt. 1, pp. 957–1004. 1896.
Shaw, E. W. Clay resources of the Murphysboro quadrangle, Illinois. In Bulletin 470.
Siebenthal, C. E. Bentonite of the Laramie Basin, Wyoming. In Bulletin 285, pp. 445–447. 1906.
Stose, G. W. White Clays of South Mountain, Pennsylvania. In Bulletin 315, pp. 322–334. 1907. 50c.
Van Horn, F. B. Fuller's earth. In Mineral Resources U. S. for 1907, pt. 2, pp. 731–734. 1908. $1.00.
——— Fuller's earth. In Mineral Resources U. S. for 1909, pt. 2, pp. 735–738. 1911.
Vaughan, T. W. Fuller's earth of southwestern Georgia and Florida. In Mineral Resources U. S. for 1901, pp. 922–934. 1902. 50c.
——— Fuller's earth deposits of Florida and Georgia. In Bulletin 213, pp. 392–399. 1903. 25c.
Veatch, O. Kaolins and fire clays of central Georgia. In Bulletin 315, pp. 303–314. 1907. 50c.
Woolsey, L. H. Clays of the Ohio Valley in Pennsylvania. In Bulletin 225, pp. 463–480. 1904. 35c.

GLASS SAND, OTHER SAND, AND GRAVEL.

By Ernest F. Burchard.

PRODUCTION.

The total production of sand and gravel in the United States in 1910 was 69,410,436 short tons, valued at $21,037,630, as compared with 59,565,551 short tons, valued at $18,336,990, in 1909, a net increase in quantity of 9,844,885 short tons and in value oı $2,700,640 over the production of 1909. The production of 1908 was exceeded by 32,194,392 short tons in quantity and by $7,767,598 in value. In the years 1909 and 1910 there was considerable activity in the building trades, especially in concrete construction work, consequently there were large increases in the consumption of sand and gravel for building purposes. The production grouped under "Other sand" showed a decrease in 1910, which was partly due to the decrease in material reported as used in railroad ballast and in filling. The production of molding sand in 1910 amounted to 3,636,167 short tons, valued at $2,431,254, as compared with 3,122,806 short tons, valued at $2,146,220, in 1909, an increase in quantity of 513,361 tons and in value of $285,034.

The production of glass sand in 1910 was 1,461,089 short tons, valued at $1,516,711, as compared with 1,104,451 short tons, valued at $1,163,375, in 1909. These figures represent an increase in quantity of 356,638 tons and in value of $353,336. The average value of glass sand per ton was slightly less than $1.04 in 1910, as compared with $1.05, the average value in 1909. The average value of molding sand per short ton in 1910 was a little less than 70 cents and of fire sand slightly under 77 cents per short ton. The other grades of sand bring much lower prices, the average ranging from about 28 cents per ton in the case of sand for filling, stone sawing, etc., to more than 56 cents for furnace sand. The average value of building sand was about 30 cents per short ton. The average value per ton for gravel in 1910 was less than 23 cents, a decrease of nearly 3 cents per ton since 1909. The gravel figures include, under Missouri, 1,901,382 tons of "chats," or tailings from the zinc mines of 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 following tables give the production of the various grades of sand and the production of gravel by States in 1909 and 1910:

Production of glass sand, other sand, and gravel in the United States in 1909 and 1910, by States and uses, in short tons.

1909.

State.	Glass sand.		Molding sand.		Building sand.		Fire sand.		Engine sand.		Furnace sand.		Other sands.		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	306,785	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)	965	$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.

Production of glass sand, other sand, and gravel in the United States in 1909 and 1910, by States and uses, in short tons—Continued.

1910.

State.	Glass sand.		Molding sand.		Building sand.		Fire sand.		Engine sand.		Furnace sand.		Other sands.		Gravel.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Alabama			56,085	$22,069	228,797	$73,567			6,350	$1,930	286	$148	16,197	$2,547	311,538	$87,330	619,253	$187,591
Arizona																		(a)
Arkansas			600	515	212,318	68,791			18,370	5,140			7,511	5,978	822,238	150,256	1,061,037	230,680
California	(b)	(b)	c 10,133	c 9,342	191,247	74,225	10,695	$8,033	25,679	6,949			22,286	14,829	1,805,257	327,572	2,065,297	440,950
Colorado			3,857	2,627	41,168	13,050			7,065	2,200			13	15	1,145,648	136,147	1,197,751	154,039
Connecticut			295	779	15,969	11,924							412	72			16,676	12,775
Delaware			1,000	600	72,707	29,721			16,141	5,009	74,208	31,539					164,056	66,869
Florida			795	785	34,063	21,127											34,858	21,912
Georgia	(d)	(d)	e 42,355	e 19,341	237,752	75,098			6,800	1,700			40,397	11,029	25,075	15,975	352,379	123,143
Hawaii																		(a)
Idaho					15,800	11,700							675	750	16,200	12,000	32,675	24,450
Illinois	268,654	$216,531	407,232	215,742	1,756,652	473,209	17,840	12,886	43,147	6,840	79,793	48,046	1,211,564	130,756	4,801,626	626,785	8,586,508	1,730,795
Indiana	(d)	(d)	e 165,357	e 85,204	1,828,023	410,046			28,902	9,213	67,065	13,400	221,419	26,825	4,107,702	500,474	6,418,468	1,045,162
Iowa			13,320	9,775	781,667	283,086			25,000	7,033	9,000	4,500	25,235	5,563	944,540	154,470	1,798,762	464,427
Kansas					609,540	142,514			24,524	3,773			37,244	4,217	105,330	15,155	776,638	165,659
Kentucky	(d)	(d)	e 57,318	e 43,788	383,179	186,054	2,780	1,952	8,104	3,360	12,016	9,335	28,062	7,834	245,891	134,123	737,350	386,446
Louisiana					208,958	66,258			4,653	778			35,535	6,827	586,149	298,473	835,295	372,336
Maine					41,569	40,313											41,569	40,313
Maryland	b 25,392	b 22,996	(c)	(c)	476,817	163,213			21,872	12,437			13,477	9,882	416,835	187,829	954,393	396,357
Massachusetts	(d)	(d)	e 13,166	e 23,630	141,686	91,287	4,144	1,405					51,787	30,724	111,077	65,670	321,860	212,716
Michigan	(d)	(d)	e 110,024	e 49,679	1,151,588	334,336	5,000	3,000	22,270	2,172	3,185	4,924	372,880	57,385	1,197,791	364,841	2,862,738	816,337
Minnesota			23,099	26,422	176,858	62,470	100	100	9,838	1,511			23,444	9,849	1,704,773	246,786	1,938,112	347,138
Mississippi			256	166	70,932	30,734			9,407	2,554			1,485	1,430	281,041	124,598	363,121	159,482
Missouri	186,342	130,686	79,977	42,787	2,525,600	571,501	35,680	16,420	65,148	12,544			145,701	79,628	3,070,012	485,953	6,108,460	1,339,519
Montana																		(a)
Nebraska					801,762	129,641			9,691	1,321			170,749	18,644	94,400	18,649	1,076,602	168,255
New Jersey	87,680	61,078	679,191	436,460	1,431,332	340,288	28,931	32,562	20,786	9,666	14,757	9,246	171,886	111,383	528,252	138,592	2,962,815	1,139,275
New Mexico					223	207							2,700	680	1,387	1,156	4,310	2,043
New York	(d)	(d)	e 536,232	e 453,362	4,605,620	1,041,587	23,485	12,585	34,020	13,044	6,315	3,140	318,196	109,690	1,605,228	671,715	7,129,096	2,305,123
North Carolina			439	396	28,031	4,989							28,875	2,994	5,590	5,027	62,935	13,406
North Dakota					5,752	4,322							420	150	9,714	6,750	15,886	11,222
Ohio	139,122	104,295	724,313	533,343	2,062,103	713,220	11,474	8,576	63,023	19,366	94,965	85,051	73,681	44,357	1,937,833	557,016	5,106,514	2,065,224
Oklahoma			90	24	276,759	87,130			3,360	830			62,256	19,204	307,771	79,789	650,236	186,977
Oregon					434,068	269,878			7,000	500					991,427	355,027	1,432,495	625,405
Pennsylvania	434,147	617,200	605,340	413,741	2,245,658	941,327	32,062	36,719	229,233	150,659	105,194	58,673	601,528	388,896	1,423,347	367,006	5,676,509	2,974,221

South Carolina	b 2,144	b 1,993	(c)	(c)	2,138	925	....	....	....	....	....	....	500,000	50,000	....	....	504,282	52,918
South Dakota	....	....	....	....	60,325	32,606	....	....	2,205	294	....	....	925	825	786,345	124,013	849,800	157,738
Tennessee	1,320	1,344	48,129	24,439	376,016	187,646	540	500	36,337	12,731	9,271	4,722	18,937	6,842	304,862	179,677	795,412	417,901
Texas	....	....	4,186	2,649	480,057	227,649	150	300	23,290	13,280	112	84	27,064	9,488	471,725	263,775	1,006,584	517,225
Utah	....	....	....	....	2,560	723	....	....	13,886	4,167	....	....	120	245	166,928	16,219	183,494	21,354
Vermont	....	....	2,268	1,736	2,950	2,170	....	....	....	....	....	....	60,000	15,000	1,200	141	66,418	19,047
Virginia	(d)	(d)	e 36,217	e 25,404	251,170	88,340	....	....	1,900	1,165	5,339	2,088	22,494	10,628	447,201	87,791	764,321	215,416
Washington	....	....	4,070	7,577	588,846	176,102	....	....	950	550	....	....	5,136	2,013	976,287	295,327	1,575,289	481,569
West Virginia	235,784	282,267	3,541	2,461	231,535	87,109	....	....	47,777	29,280	11,500	3,350	53,982	13,878	161,122	56,116	745,241	474,461
Wisconsin	(d)	(d)	e 87,786	e 54,732	638,861	256,284	4 2,200	1,323	41,683	7,149	560	800	39,909	12,524	640,759	92,751	1,451,758	425,563
Other States f	....	....	....	....	14,416	6,271	....	....	....	....	....	....	24,246	16,784	24,521	1,136	63,183	24,191
Total	g 1,380,585	g 1,438,390	h 3,716,671	h 2,509,575	25,743,072	7,832,638	175,081	136,361	878,411	349,145	493,566	279,046	i 4,438,428	i 1,240,365	32,584,622	7,252,110	69,410,436	21,037,630

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, and Montana.
g The exact output of glass sand was 1,461,089 tons, valued at $1,516,711.
h The exact output of molding sand was 3,636,167 tons, valued at $2,431,254.
i Includes sand for grinding and polishing stone and glass, filtration sand, railroad filling and ballast, brick molding, for asphalt paving and blocks, etc.

The unit of measurement given in the foregoing 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, according to the material of which the gravel is composed, and according 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 sand; hence, the quantities reported were all reduced to this unit.

The following table gives the total production of sand and gravel in the United States in each of the last nine years:

Quantity and value of sand and gravel produced in the United States, 1902–1910, in short tons.

Years.	Sand and gravel.	
	Quantity.	Value.
1902	1,847,901	[a] $1,423,614
1903	2,110,660	[a] 1,831,210
1904	10,679,728	[a] 5,748,099
1905	23,204,967	11,223,645
1906	32,932,002	12,698,208
1907	41,851,918	14,492,069
1908	37,216,044	13,270,032
1909	59,565,551	18,336,990
1910	69,410,436	21,037,630

[a] Includes only a very small quantity of gravel.

The following table gives the total production of glass sand in the United States in each of the last nine years:

Quantity and value of glass sand produced in the United States, 1902–1910, in short tons.

Years	Glass sand.	
	Quantity.	Value.
1902	943,135	$807,797
1903	823,044	855,828
1904	858,719	796,492
1905	1,060,334	1,107,730
1906	1,089,430	1,208,788
1907	1,187,296	1,250,067
1908	1,093,553	1,134,599
1909	1,104,000	1,163,375
1910	1,461,089	1,516,711

IMPORTS.

Sand valued at $133,757 was imported into the United States in 1910, as compared with imports valued at $106,234 in 1909 and at $77,574 in 1908.

PUBLICATIONS.

Papers in which the occurrence, distribution, character, relation to markets and fuel supplies, and methods of extraction and preparation of glass sand and other sands are discussed are listed as follows:

Weeks, Joseph D., Glass materials: Mineral Resources U. S. for 1883 and 1884, U. S. Geol. Survey, 1885, pp. 958–973.

——— Glass materials: Mineral Resources U. S. for 1885, U. S. Geol. Survey, 1886, pp. 544–555.

Campbell, M. R., Description of the Brownsville-Connellsville quadrangles, Pennsylvania: Geologic Atlas U. S., folio 94, U. S. Geol. Survey, 1903, p. 49.

Coons, A. T., Glass sand: Mineral Resources U. S. for 1902, U. S. Geol. Survey, 1904, pp. 1007–1015.

Burchard, E. F., Requirements of sand and limestone for glass making: Bull. U. S. Geol. Survey No. 285, 1906, pp. 452–458.

——— Glass sand of the middle Mississippi basin: Bull. U. S. Geol. Survey No. 285, 1906, pp. 459–472.

——— Glass-sand industry of Indiana, Kentucky, and Ohio: Bull. U. S. Geol. Survey No. 315, 1907, pp. 361–376.

——— Notes on glass sands from various localities, mainly undeveloped: Bull. U. S. Geol. Survey No. 315, 1907, pp. 377–382.

——— Production of glass sand, other sand, and gravel in 1908: Mineral Resources U. S. for 1908, U. S. Geol. Survey, 1909, pp. 505–510.

——— Concrete materials produced in the Chicago district: Bull. U. S. Geol. Survey No. 340, 1908.

——— Production of glass sand, other sand, and gravel in 1909 (includes numerous analyses): Mineral Resources U. S. for 1909, pt. 2, U. S. Geol. Survey, 1911, pp. 519–542.

——— Field investigations of structural materials: Bull. U. S. Geol. Survey No. 430, 1910.

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Stose, G. W., Glass-sand industry in eastern West Virginia: Bull. U. S. Geol. Survey No. 285, 1906, pp. 473–475.

Kümmel, Henry B., and Gage, R. B., The glass-sand industry of New Jersey: Ann. Rept. New Jersey Geol. Survey for 1906, 1907, pp. 77–96.

Rock Products, An up-to-date Illinois (sand) plant; January 22, 1908, pp. 63–64.

——— Gravel washing at the plant of the Southern Gravel and Material Company, Brookhaven, Miss.; September 22, 1909, p. 50.

——— Washing plant of Akron Gravel and Sand Company; November 22, 1909, p. 33.

——— Standard testing sand; November 22, 1909, p. 31.

——— Gravel-washing plant of the Lake Shore Sand Company, near Algonquin, Ill.; December 22, 1909, p. 33.

——— Joliet Sand and Gravel Company; January 22, 1910, p. 37.

——— New plant of the Washed Sand and Gravel Company, Minneapolis, Minn.; April 22, 1910, p. 34.

The Engineering Record, Washer for concrete aggregates; June 26, 1909, p. 805.

——— Washing sand and gravel; November 13, 1909, p. 551.

——— The Bernhart sand filters, Reading, Pa.; November 13, 1909.

——— Gravel-washing plants; January 15, 1910, pp. 84–85.

Shaw, E. W., Gravel and sand in the Pittsburgh (Pa.) district: Bull. U. S. Geol. Survey No. 430, 1910.

Some other papers recently published, which deal with sand and gravel as constituents of concrete, are the following:

Humphrey, R. L., and Jordan, W., Jr., Portland cement mortars and their constituent materials: Bull. U. S. Geol. Survey No. 331, 1908.

Humphrey, R. L., The strength of concrete beams: Bull. U. S. Geol. Survey No. 344, 1908.

Larned, E. S., Sand in concrete: Rock Products, February 22, 1908, p. 74.

Spackman, H. S., and Lesley, R. W., Sands, their relation to mortar and concrete: Cement Age, July and August, 1908.

Journal Association of Engineering Societies, Cement and sand for concrete; November, 1909.

Proceedings American Society of Civil Engineers, Impurities in sand for concrete; September, 1909.

Avery, Colby M., Washed sand and gravel for concrete or mortar uses: Rock Products, August 22, 1909, p. 29.

The following five papers contain much valuable information concerning molding and foundry sands:

Merrill, G. P., Guide to the study of the collections in the section of applied geology. Nonmetallic minerals: Rept. U. S. Nat. Mus. for 1899, 1901, pp. 474–477.

Eckel, Edwin C., Molding sand, its uses, properties, and occurrence: Twenty-first Rept. New York State Geologist, 1901, pp. 91–96.

Kümmel, H. B., and others, Report upon some molding sands of New Jersey: Ann. Rept. State Geologist of New Jersey for 1904, 1905, pp. 189–246.

Ries, Heinrich, The clays of Wisconsin and their uses, with a report on molding sands: Bull. Wisconsin Geol. and Nat. Hist. Survey No. 15, 1906.

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LIME.

By Ernest F. Burchard.

PRODUCTION.

The total production of lime in 1910, as reported to the United States Geological Survey, was 3,481,780 short tons, valued at $13,894,962, as compared with 3,484,974 short tons, valued at $13,846,072, in 1909. This represents a slight decrease in tonnage of 3,194 tons, and an increase in value of $48,890. The average price per ton in 1910 was $3.99, as compared with $3.97⅓ in 1909, or an increase of 1⅔ cents a ton. The total number of producers reporting in 1910 was 1,125, as compared with 1,234 in 1909, a decrease of 109. This apparently large decrease in the number of producers was due partly to the inactivity of a number of small kilns operated by farmers for burning lime for local use as fertilizer, and partly to the abandonment of old and worn-out kilns. The heaviest decrease in the number of producers was in Pennsylvania, but Porto Rico, Maryland, West Virginia, and Wisconsin showed marked decrease. In 1909, 44 States, including Hawaii and Porto Rico, reported production of lime; in 1910 Nevada failed to report a production, leaving 43 States as producers. The five leading States in 1910 were, in the order of their production, Pennsylvania, Ohio, Wisconsin, Maine, and Missouri. Pennsylvania produced 877,714 short tons of lime in 1910, valued at $2,440,350, the average price being $2.78 per ton. There were 572 active producers in Pennsylvania, including a considerable number of farmers who produced only a few hundred bushels each for fertilizer. The Pennsylvania production represented a decrease in quantity of 3,725 short tons, and in value of $92,104, as compared with 1909, the price falling 9 cents per ton. In Ohio 415,285 short tons were reported in 1910, valued at $1,647,335, representing an increase in quantity of 71,531 short tons, and in value of $405,616. The average price per ton in 1910 was $3.97, an increase of 35 cents over the price in 1909. There were 36 producers in Ohio in 1910 as compared with 33 in 1909. In 1910 Wisconsin produced 248,238 short tons of lime, quarried from native rock, valued at $959,405, besides 21,000 tons burned from stone imported from other States. The stone imported from other States was mainly high-calcium limestone, the lime from which was used by beet-sugar refiners. The 1910 production in Wisconsin as compared with that of 1909 represented a decrease in quantity of 20,012 short tons, and in value of $108,095. The price per ton in 1910 was $3.86 as compared with $3.98 the preceding year, and there were 40 producers in 1910 as compared with 46 in 1909. Maine produced 179,656 short tons of lime in 1910, valued at $893,599, at an average price of $4.97 per ton, an increase in quantity of 1,092 tons, but a decrease in value of $64,091 and an average price of 39 cents. In 1910 there were 7 producers as compared with 9 in 1909. In 1910 Missouri produced 179,550 short tons of lime, valued at $846,123, the average value per ton being $4.71. As compared with the production in 1909 this was a decrease in quantity of 2,910 tons and an increase in value of $30,756, with an increase in average price per ton of 24 cents. The number of operators reporting production was the same for the two years.

In 1910 there were 52 manufacturers of hydrated lime, as compared with 50 in 1909, and the production in 1910 was 320,818 short tons, valued at $1,288,789, an average price per ton of $4.02, as compared with 204,611 short tons, valued at $904,900, or an average price of $4.43 per ton in 1909.

The following table gives the value of the total lime production in the United States for the years 1896 to 1910, inclusive:

Value of lime produced in the United States, 1896–1910.

1896	$6, 327, 900	1904	$9, 951, 456
1897	6, 390, 487	1905	10, 941, 680
1898	6, 886, 549	1906	12, 480, 653
1899	6, 983, 067	1907	12, 656, 705
1900	6, 797, 496	1908	11, 091, 186
1901	8, 204, 054	1909	13, 846, 072
1902	9, 335, 618	1910	13, 894, 962
1903	9, 255, 882		

Detailed statistics of the production of lime in 1909 and 1910 are given in the following table:

Quantity and value of lime burned in the United States in 1909 and 1910, by States, in short tons.

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	134, 732	575, 220	4.27	36
30	North Carolina	9, 881	44, 148	4.47	7
2	Ohio	343, 754	1, 241, 719	3.61	33

Quantity and value of lime burned in the United States in 1909 and 1910, by States, in short tons—Continued.

1909—Continued.

Rank of State.	State.	Quantity.	Value.	Average price per ton.	Number of operators.
34	Oregon	3,205	$29,305	$9.14	7
1	Pennsylvania	881,439	2,532,454	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	79,903	251,945	3.15	22
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	25,980	139,053	4.53	7
31	Rhode Island			4.46	
32	South Carolina			5.03	
	Total	3,484,974	13,846,072	3.97	1,234

1910.

Rank of State.	State.	Quantity.	Value.	Average price per ton.	Number of operators.
13	Alabama	81,696	$303,612	$3.72	14
26	Arizona	13,728	68,055	4.96	4
22	Arkansas	26,532	127,068	4.79	8
8	California	63,759	613,242	9.60	17
31	Colorado	8,057	40,860	5.07	7
11	Connecticut	93.576	417,850	4.47	14
28	Florida	10,482	58,386	5.57	3
35	Georgia	7,621	29,961	3.93	5
29	Idaho	8,094	48,298	5.97	7
10	Illinois	113,239	503,581	4.45	14
15	Indiana	86,811	301,304	3.47	10
25	Iowa	15,481	81,775	5.28	4
42	Kansas	1,510	7,503	4.97	5
39	Kentucky	3,622	12,468	3.44	9
4	Maine	179,656	893,599	4.97	7
12	Maryland	121,555	377,236	3.10	46
6	Massachusetts	140,942	758,739	5.38	10
14	Michigan	72.345	303,377	4.19	10
23	Minnesota	21,020	96,150	4.57	5
5	Missouri	179,550	846,123	4.71	27
36	Montana	4,480	26,925	6.01	4
21	New Jersey	34,148	128,964	3.78	20
38	New Mexico	4,445	17,930	4.03	5
7	New York	146,474	620,564	4.24	37
32	North Carolina	9,952	40,455	4.07	7
2	Ohio	415,285	1,647,335	3.97	36
41	Oklahoma	2,140	9,700	4.53	3
27	Oregon	6,742	65,039	9.65	10
1	Pennsylvania	877,714	2,440,350	2.78	572
40	Porto Rico	2.564	10,160	3.96	19
37	South Dakota	4,151	25,399	6.12	5
16	Tennessee	88,679	275,701	3.10	17
19	Texas	48,200	226,952	4.71	10
24	Utah	15,625	88,030	5.63	13
20	Vermont	38,667	203,606	5.27	9
9	Virginia	141,257	563,567	3.99	48
18	Washington	35,540	267,735	7.53	10
17	West Virginia	90,419	274,205	3.03	37
3	Wisconsin	248,238	959,405	3.86	40
43	Wyoming	143	1,783	12.47	3
30	Hawaii			8.56	
34	Rhode Island	17,641	111,970	8.00	4
33	South Carolina			4.36	
	Total	3,481,780	13,894,962	3.99	1,125

USES OF LIME.

Few mineral products have so wide a variety of uses as lime. Nearly half the lime manufactured in the United States is used as a structural material, and the remainder, amounting to about 1,750,000 tons, valued at about $5,500,000, 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 of the original limestone: (1) High calcium lime, containing 90 per cent of 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 and impurities such as silica, alumina, and iron oxide. Recent tests [1] 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.[2]

Agricultural industry:
- As a soil amendment, c, m.[3]
- 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 industries:
- Manufacture of ammonia, c.
- Manufacture of calcium carbide, calcium cyanimid, and calcium nitrate, c.
- Manufacture of potassium dichromate and sodium dichromate, c.
- Manufacture of fertilizers, c, m.
- 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.

Chemical industries—Continued.
- In refining mercury, c.
- In dehydrating alcohol, c.
- In distillation of wood, c.

Gas manufacture:
- Purification of coal gas and water gas, c, m.

Glass manufacture:
- Most varieties of glass and glazes, c.

Milling industry:
- Clarifying grain, c, m.

Miscellaneous manufactures:
- Rubber, c, m.
- Glue, c, m.
- Pottery and porcelain, c, m.
- Dyeing fabrics, c, m.
- 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.

[1] Emley, W. E., Tests of lime: Trans. Nat. Lime Mfrs. Assoc., 1911, p. 196.
[2] Notes on the part played by lime in these industries are given in Circular No. 30 of the Bureau of Standards, 1911, pp. 13–21.
[3] High calcium lime is indicated by "c," magnesian and dolomitic lime by "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 and purifying, c.

The following table gives the total lime marketed in 1909 and 1910 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.

Production of lime in the United States in 1909 and 1910, by uses, in short tons.

1909.

	Quantity.	Value.	Average price per ton.
Building lime	1,906,146	$8,396,774	$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	609,356	1,673,349	2.75
Dealers—uses not specified	321,530	1,414,919	4.40
Other uses [a]	117,217	466,325	3.98
Total	3,484,974	13,846,072	3.97
Hydrated lime, included in total	204,611	904,900	4.43

1910.

	Quantity.	Value.	Average price per ton.
Building lime	1,722,488	$7,333,837	$4.26
Alkali works	10,644	40,127	3.72
Chemical works	182,043	696,313	3.82
Paper mills	286,922	1,079,556	3.76
Sugar factories	29,421	239,536	8.14
Tanneries	28,921	133,640	4.62
Fertilizer	585,876	1,739,308	2.93
Dealers—uses not specified	496,930	2,120,685	4.27
Other uses [a]	138,535	511,960	3.70
Total	3,481,780	13,894,962	3.99
Hydrated lime, included in total	320,819	1,288,789	4.02

[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.

IMPORTS.

The imports of lime for consumption in the United States in 1910 were reported by the Bureau of Statistics as 6,498 short tons, valued at $63,791, as compared with 8,687 short tons, valued at $75,556 in 1909, a decrease in quantity of 2,189 tons and in value of $11,765.

EXPORTS.

In 1910 there was exported from the United States 164,602 barrels of lime, valued at $127,952.

FUELS.

Lime is burned with a number of different fuels. The single fuel used most extensively by plants in the United States at present is coal, followed in order by wood, coke, producer gas, natural gas, and oil. A large variety of mixtures is also employed, such as coal and coke, coal and wood, coke and wood, coke and shavings, and shavings and manure. At some plants different kilns are equipped to use different fuels. In their reports to the Survey many such plants have not differentiated the number of kilns running on the several fuels. Therefore these reports have been entered in the columns in the following table under "Mixed and miscellaneous fuels."

It is probable that if wood were universally abundant it would be more generally used than coal. Lime can generally be burned more slowly and at a lower temperature with wood than with other fuels. The lower the temperature at which a lime is burned the better its quality will be, since the activity of the impurities is less the lower the temperature is. Moreover, the minimum temperature for the decomposition of calcium carbonate may be decreased by the introduction of steam into the kiln. The presence of steam in the gases of combustion from wood, therefore, tends to produce a better quality of lime.

With the diminution in the supply of wood, gaseous fuels that may be closely controlled have begun to increase in use, and at present there seems to be considerable interest in the possibilities of producer gas. The efficiency of this fuel is being carefully noted by the firms using it, and it is reported that under the most unfavorable conditions one kiln at St. Louis made 3½ pounds of lime to 1 pound of coal,[1] as compared with an average of 2.4 pounds of lime to 1 pound of the same coal for coal-burned lime. The same manufacturer reports making as high as 4½ pounds of lime at times, and others have had as good success.

The following table gives, by States and plants, the kind of fuel used in the lime industry in 1910, so far as reported to the Survey:

[1] Cobb, C. W. S., A lime manufacturer's experience with (producer) gas as fuel: Trans. Nat. Lime Mfrs. Assoc., 1911, pp. 82-93.

Kinds of fuel used in burning lime, by States and plants.

State.	Kinds of fuel and number of plants.						Mixed and miscellaneous fuels.		Total number of plants reporting.
	Coal.	Wood.	Oil.	Natural gas.	Producer gas.	Coke.	Coal with coke, oil, or natural and producer gas.	Wood with coal, coke, oil, gas, or shaving, etc.	
Alabama	2	2			1	1		8	14
Arizona		4							4
Arkansas		8							8
California		6	5			2		3	16
Colorado	5	1							6
Connecticut	1	3							4
Florida		3							3
Georgia	2	1						1	4
Hawaii			1						1
Idaho	2	5							7
Illinois	2	7						8	17
Indiana	5	1					1	4	11
Iowa	1	2							3
Kansas	1			2				1	4
Kentucky	1	5							6
Maine	1	4	1					1	7
Maryland	30	3				2	4	5	44
Massachusetts	4	3					1	2	10
Michigan	1	10							11
Minnesota		4						1	5
Missouri		13			1			12	26
Montana		4							4
New Jersey	13	2			1		1	1	18
New Mexico	2	3							5
New York	16	6			1		2	2	27
North Carolina		2						1	3
Ohio	13	7		[a]3	4		2	8	37
Oklahoma		2							2
Oregon		5						2	7
Pennsylvania	396	10	1	2		5	17	69	500
Porto Rico		15							15
Rhode Island	1								1
South Carolina	1								1
South Dakota		4						1	5
Tennessee	3	3			1	2	1	8	18
Texas	2	3				1		3	9
Utah	7	1					1		9
Vermont		8						1	9
Virginia	16	10			1	3		12	42
Washington		10							10
West Virginia	14			1	1	3	1	5	25
Wisconsin		42						2	44
Wyoming	1	2							3
Total	543	224	8	8	11	19	31	161	1,005

[a] Includes 1 plant using also producer gas.

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 is stirred by machinery, the chemical principle involved is the same, viz, quicklime plus water becomes 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 becomes 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 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 ½-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 object of crushing the product is to produce a larger surface for the action of the water, and, moreover, large lumps would be rather unwieldy in the hydrater. The lime comes from the hydrater as a fine, dry powder, which must be screened to remove any coarse or overburned lime that would not slake. From the screens it goes to the storage bin, where, if the capacity is available, it is at some plants allowed to age for 30 days. Finally, the product is fed into bags for shipment. The equipment of the hydrating plant generally includes two elevators, one to take the lime from the crusher to the bin over the hydrater, and one to take the hydrated lime from the hydrater to the storage bin. Most mills include, also, a machine for grinding the oversize from the screens. This material consists of unburned stone, overburned lime, lime which is not fully hydrated, and even pieces of brick from the kilns, and coal ashes. When ground, the tailings may be sold for fertilizer. The methods of manufacture most extensively employed in this country are the batch process, the continuous process, and modifications of these two processes.

The following table shows the number of lime hydrating plants reported to the Survey as operating in the United States during the last five years, and draws attention to the steady development of this phase of the lime industry:

Number of lime-hydrating plants in operation in 1906–1910, by States.

State.	1906	1907	1908	1909	1910
Alabama	1	1	1	3	2
Arizona	1	1	1	1	1
California	....	1	2	2	2
Colorado	....	1	....	1	1
Connecticut	1	....	....	1	....
Florida	....	....	1	....	1
Georgia	2	1	1	....	....
Hawaii	....	....	....	....	1
Idaho	....	....	....	1	1
Illinois	....	1	1	2	2
Indiana	2	2	2	2	2
Iowa	1	....	....	1	....
Kansas	1	1	....	1	....
Maine	1	1	1	1	1
Maryland	....	....	1	1	3
Massachusetts	....	....	....	....	1
Michigan	1	1	2	1	1
Missouri	....	2	2	3	3
New Jersey	....	....	1	1	....
New York	1	2	2	3	....

Number of lime-hydrating plants in operation in 1906–1910, by States—Continued.

State.	1906	1907	1908	1909	1910
Ohio	8	9	11	8	8
Pennsylvania	8	6	11	9	8
Porto Rico					1
South Dakota					1
Tennessee			1	1	1
Texas			1	3	3
Virginia			1	2	
West Virginia	1	1	1		2
Wisconsin	1	2	2	2	2
Total	30	33	46	50	52

TECHNOLOGIC INVESTIGATIONS OF LIME.

In June, 1909, the United States Geological Survey, in cooperation with the National Lime Manufacturers' Association, began a study of lime. Both field and office work were undertaken. In the field the conditions prevailing as to quarrying, crushing, burning, and hydrating were studied, and samples of stone, burned lime, and hydrated lime were collected from a wide territory embracing nearly all the States east of Missouri River and from quarries in various types of stone, grading from high-calcium to high-magnesian lime. In collecting the samples of stone the geologic formations in which the quarry was situated were noted, as well as the dip and strike of beds and their lithologic and structural features that might have a bearing on the quarrying and utilization of the stone. In the laboratory, which was situated at Pittsburgh, Pa., the work included chemical analyses and physical tests of the limestone and chemical and physical tests of quick lime and hydrated lime. The principal aim of the investigation is to show the effect of impurities contained in various limes, the effect of low and high temperatures on the quality of the lime burned, the different degrees of plasticity produced by different limes, the strength of the lime mortars, and to determine, if possible, the best conditions for hydration. The work was carried on for about one year under the United States Geological Survey, but on July 1, 1910, the structural-materials laboratories at Pittsburgh were transferred to the Bureau of Standards, under which organization the work has been continued. The laboratory work has been performed principally by W. E. Emley, assistant chemist. Some preliminary results have been published by the National Lime Manufacturers' Association and by the Bureau of Standards, as indicated in the list of publications at the end of this chapter.

The quality of lime has become of such importance to the consumer that it is necessary to devise specifications which shall serve as a basis for mutual understanding between consumer and manufacturer. Such specifications involve a thorough study of the properties of lime, how these properties must vary to meet the demands of different consumers, what tests must be made to indicate to what degree any limestone or any lime possesses these properties, and how to make the tests. For building limes the factors of most importance are sand-carrying capacity, crushing strength, and tensile strength; for plastering limes these factors are spreading quality, time of setting, color, hardness, and constancy of volume. Mr. Emley has made a preliminary statement of tentative tests as follows:[1]

To all users of lime the content of carbon dioxide is important as indicating to what extent the lime has air-slaked or spoiled. The rate of hydration is also important as a means of determining whether or not the lime has been properly burned.

For chemical or agricultural uses a complete chemical analysis, or at least the determination of calcium oxide, becomes necessary.

Building lime should be tested for crushing strength, tensile strength, and sand-carrying capacity.

For plastering lime the time of set, plasticity, color, hardness, and constancy of volume are important.

Since the chemical analysis of lime is of more interest to the chemist than to the technical man, mere references will be made to some new, quick methods.

The carbon dioxide can be determined by means of an alkalimeter, the rate of hydration by means of a calorimeter. The color may be measured by direct comparison with a series of standards. These standards consist of mixtures of chemically pure calcium carbonate and lead peroxide in various proportions, giving all shades from white to brown. By the use of a viscosimeter, the viscosities of lime paste with different quantities of water can be determined, and a correlation of these should give a comparative indication of the spreading quality. It has been found necessary, in determining viscosities, to have some standard means of preparation of the sample. For this purpose a uniform temperature slaking apparatus has been devised. The Clark viscosimeter is being used for thin pastes; a plunger viscosimeter is also in use. For all other tests a standard lime paste must be used.

A standard lime paste may be prepared as follows: Determine the viscosity of a paste which has the proper consistency for practical work. Call this the standard viscosity. Then, from the viscosities of pastes made with different quantities of water, find by interpolation how much water is required to give a paste of the standard viscosity with the particular lime in question. This quantity of water is to be used in mixing pastes for the succeeding tests, and the paste so produced shall be known as the "standard lime paste." By using this standard the consistencies of the pastes used will be identical, and therefore the results of the tests will be more nearly comparable.

For testing crushing strength and tensile strength use a mortar consisting of standard lime paste and sand, the sand being in the ratio of 3 : 1 by weight to the dry lime. The molds for crushing specimens are to be cubes, 2 inches on a side; for tensile specimens, the customary briquets have a cross section of 1 square inch at the center. All specimens are to be stored in air and broken when three months old.

To test sand-carrying capacity, make up specimens as for crushing strength, except that the proportion of sand is to vary from 0 to 5 times the weight of the lime. Store and break as for crushing strength.

Some of these specimens containing no sand are to be measured when three months old, in order to determine the constancy of volume.

To determine the time of set, use the standard lime paste under a Vicat needle and follow the official specifications adopted for testing cement. That is, the initial set is said to have occurred when the needle penetrates to a point 5 millimeters from the bottom; the final set when there is no noticeable penetration.

Hardness is to be determined by exposing the standard lime paste, one week old, to the action of a sand blast and noting the rate at which it is worn off.

The tests outlined above are the ones it is hoped may be used in the original tentative draft of specifications. In order to arrive at these methods of testing, many experiments were carried out.

In making tests along the lines indicated above, Mr. Emley found that samples of both quick and hydrated lime shipped to the labortory in practically air-tight packages kept very well. In the case of hydrated lime shipped in commercial packages there was some deterioration, as shown by the amount of carbon dioxide absorbed. Experiments showed that the hydrated lime did not keep any better in air than ground quicklime, and it was not proved that hydrated lime may be stored indefinitely without spoiling. In the crushing and tensile-strength tests it was found that magnesian limes

[1] Emley, W. E., Tests of lime: Trans. Nat. Lime Mfrs. Assoc., 1911, pp. 192–194.

were stronger than high calcium limes. Although this may be of some advantage in structural work, it is well known that high calcium lime possesses the requisite strength for nearly all practical purposes.

Another important subject under investigation by the Bureau of Standards is the burning temperature of limestone. According to Bleininger and Emley:[1]

The problem of burning limestone would be a very simple one if we were dealing with pure carbonates. If this were the case the lime could not be overburnt under the conditions of burning, and likewise the magnesia would have a temperature range sufficiently wide for all practical purposes. Unfortunately this is not the case. All limestones carry impurities in the shape of clay, silica, iron oxide, alkalies, carbon, pyrites, etc. It happens that most of these impurities are more or less acid in character, being opposite in this respect to the lime and magnesia which are basic. Since there is, however, the tendency on the part of all acid and basic substances to combine to form compounds, it is evident that silica will produce silicates of lime and magnesia; alumina, aluminates; and ferric (iron) oxide, ferrates. While lime itself is practically infusible as far as industrial temperatures are concerned, the various silicates, aluminates, and ferrates are comparatively fusible. In heating limestone to its dissociation temperature, we are also causing heat to affect its impurities. A curious and interesting natural law begins to operate in this connection, the working out of which it is of interest to note. As soon as the stone is heated to about its practical dissociation temperature the impurities mentioned combine with the lime in such proportions that the resulting mixture begins to soften, indicating incipient fusion. In other words, the silica, alumina, and iron oxide combine with just sufficient lime to bring about this result, and no more. We are dealing hence with an automatic selection of a fusible matrix which is constant only for a certain temperature. On raising the temperature the amount of fusible matter increases, and hence its composition must change. It will bring into this matrix some more lime. Hence, as the temperature rises, the fluxes become more and more potent by combining with increasing amounts of lime. For instance, while an impure stone may be heated to, say, 1,830° F. and still produce a saleable lime, at, say, 2,200° F. the impurities with their combined lime constitute such a large portion of the total mass, which on account of its softening closes up the pores and envelops the particles of lime by a slaglike coating, that the lime slakes but difficultly and hence has lost part or all of its commercial value.

It must be realized that there is another important function connected with the softening of the impurities and their quota of lime. In all rocks which have been heated to their incipient softening temperature a force is operative which tends to close up all the pores. A lump of limestone in the kiln might be imagined to be acted upon on all sides by surface forces which tend to contract it, to make it smaller, thus closing up all the poral spaces. In pure lime this force is ineffective, as there is no softening at these temperatures. It therefore remains porous, and it is practically impossible to overburn it.

The impurities of limestone for this reason not only are objectionable on account of their mere presence but much more so due to their action just described. This might be illustrated by an example. Supposing we are dealing with a limestone which has the following composition:

	Per cent.
Carbonate of lime	96.36
Carbonate of magnesia	.74
Silica	1.41
Alumina	.25
Ferric oxide	.40

What is the amount of lime actually available as such? Assuming that dicalcium silicate, tricalcium aluminate, and tricalcium ferrate are formed, we have left 96.36 − (4.70 plus 0.75 plus 0.75) equals 90.16 per cent of carbonate which goes to make free lime. The impurities thus have withdrawn a share of the lime from active service. In addition they have closed up the pores of the lumps more or less and have hardened the structure.

[1] Bleininger, A. V., and Emley, W. E., The burning temperature of limestone: Trans. Nat. Lime Mfrs. Assoc., 1911, pp. 68–69.

The results of this investigation so far as it had been carried out to the end of 1910 may be summarized as follows:

1. The minimum calcination temperature of high calcium stone was found to be 1,616° F. and of magnesium carbonate to be 1,382° F.

2. The limiting burning temperature of limes may be determined from the study of the hydration curves of limes burnt at different temperatures. In these the temperature rise of a certain weight of water heated by the slaking of a given amount of lime is plotted against time. This method, therefore, offers a method of fixing the proper burning temperature of a given lime.

3. The maximum temperature permissible for pure calcium stones is above 2,300° F.; of impure high-calcium stones it is 1,900° to 2,200° F.; of pure magnesian lime, 1,830° to 1,900° F.; of impure magnesia stone, 1,650° to 1,900° F.

4. The porosity-temperature curve of a lime likewise gives valuable information in regard to the best burning temperature which is represented by the point of maximum porosity. The slope of the curve is a significant measure of the danger of overburning. The steeper the slope the greater this tendency, and vice versa.

5. The density curve of a limestone confirms the evidence given under No. 4, and brings out additional information as regards the burning behavior of magnesian limestone.

6. The more porous a limestone is in its natural condition, the more easily it will burn, that is, the more rapidly and at a lower temperature. Porous stone may be completely burnt at 1,652° F., but dense stones require 1,832° F.

PUBLICATIONS.

Owing to the interest that is being shown by correspondents of the Survey in the lime industry and to the fact that the Survey has heretofore been unable to give to this subject the attention that it merits, a partial list of the more important recent publications, covering a wide range of topics, is given below. These publications naturally fall into two groups: (1) On raw materials, and (2) on the manufacture, properties, kinds, and uses of lime. High-calcium limestone that is suitable for the manufacture of Portland cement is generally suitable for the manufacture of lime, and elsewhere in the volume Mineral Resources for 1910 is given a more complete list of publications by State and United States geological surveys on limestones available for making cement.

The United States Geological Survey distributes its own publications only. For State publications applications should be made to the State geologists, and private publications should be obtained direct from the publishers.

PUBLICATIONS ON LIMESTONE.

Arkansas: Hopkins, T. C., Marbles and other limestones (of Arkansas). Ann. Rept. Arkansas Geol. Survey for 1890, 1893, vol. 4, 443 pp.

California: Aubury, Lewis E., The structural and industrial materials of California. Bull. California State Min. Bur., No. 38, 1906, pp. 171–189.

Georgia: McCallie, S. W., Marbles of Georgia. Bull. Georgia Geol. Survey No. 1, 2d ed., 1907, 126 pp.

Illinois: Udden, J., and Todd, J. E., Structural materials in Illinois. Bull. Illinois State Geol. Survey No. 16, 1910, pp. 342–390.

Iowa: Beyer, S. W., and Williams, Ira A., The geology of quarry products. Iowa Geol. Survey, vol. 17, 1906, pp. 187–584.

Maine: Bastin, E. S., The lime industry of Knox County, Me. In Bull. U. S. Geol. Survey No. 285, 1906, pp. 393–400.

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, 1910, pp. 225–484, 14 pls., map.

Missouri: Buehler, A. H., Lime and cement resources of Missouri. Missouri Geol. Survey, vol. 6, 2d ser., 1907, 255 pp.

New Jersey: Kümmel, H. B., The chemical composition of the white crystalline limestones of Sussex and Warren counties. Ann. Rept. New Jersey State Geologist for 1905, pp. 173–192.

NEW YORK: Ries, H., Lime and cement industries of New York. Bull. New York State Mus., No. 44, 1903, pp. 640–848.
OHIO: 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.
PENNSYLVANIA: Clapp, F. G., Limestones of southwestern Pennsylvania. In Bull. U. S. Geol. Survey No. 249, 1905, 52 pp.
PHILIPPINE ISLANDS: Adams, George I., Mineral resources of southwestern Luzon. Min. World., Sept. 10, 1910, pp. 463–465.
GENERAL: Burchard, Ernest F., Elements of geology as applied to limestone quarrying. Trans. Nat. Lime Mfrs. Assoc., 1910, pp. 56–65.
Warner, Irving, Glossary of terms. Mason Builder, September, 1910, p. 142; October, 1910, p. 158. See also Trans. Nat. Lime Mfrs. Assoc., 1910, pp. 14–24.

PUBLICATIONS ON LIME.

Anon., The iron-lime process of water purification. Eng. Rec., Oct. 9, 1909, pp. 403–404.
——— Lime, its properties and uses. U. S. Bur. Standards, Circ. 30, 1911, 22 pp.
Beyer, S.W., Physical tests of Iowa limes. Iowa Geol. Survey, vol. 17, 1906, pp. 91–150.
Graham, J. B., Lime as a fertilizer. Rock Products, vol. 9, No. 10, Apr. 22, 1910, pp. 33.
McCullough, Ernest, Methods of manufacturing hydrated lime. Mining World, Dec. 3, 1910, pp. 1049–1050.
Meade, R. K., The manufacture and properties of hydrated lime. Eng. News, May 11, 1911, p. 554. See also Bull. 19, Nat. Lime Mfrs. Assoc., 1911.
Nagel, Oscar, Gas firing for lime and cement kilns. Cassiers Mag., September, 1909, pp. 408–419.
Transactions of the National Lime Manufacturers' Association:
1909: Bachtenkircher, H. E., The hydration problem to date, 1909, pp. 337–340.
Bleininger, A. V., The physical properties of lime, pp. 365–369.
Hunkins, D. S., Development of limekiln construction in the Middle West, pp. 345–351.
Lazell, E. W., The standardization of hydrated lime, pp. 361–365.
Peppel, S. V., Heat temperatures in limekilns as related to the fuel problem, pp. 370–377.
Spencer, A. N., A study of the limekiln lining problem, pp. 351–359.
Wall, Edward E., The use of lime for water purification at St. Louis, Mo., pp. 330–337.
Wing, Charles B., The necessity of lime in growing alfalfa, pp. 377–379.
1910: Anon., Classification of lime for agricultural purposes, pp. 7–8.
——— Glossary of terms in connection with manufacture of lime, pp. 14–24.
Ashley, Harrison Everett, The spreading and setting properties of lime mortars, pp. 43–47.
Bachtenkircher, H. E., Some further observations on the hydration problem, pp. 73–77.
Broomell, A. P., The modern limekiln, pp. 66–69.
Emley, Warren E., Kiln design, pp. 90–107.
——— Some investigations on lime, pp. 48–50.
Fippin, Elmer O., The relation of lime to soil improvement, pp. 78–89.
Gawthrop, H. A., How should the modern kiln be constructed, pp. 28–37.
Schmatolla, E., Producer-gas fired lime plants, pp. 108–112. See also Chem. Eng., March, 1910, pp. 73–76.
1911: Bachtenkircher, H. E., The development of hydration in 1910, pp. 209–212.
Cobb, C. W. S., A lime manufacturer's experience with gas as fuel, and the gas producer as applied to the manufacture of lime, pp. 82–86.
Bleininger, A. V., and Emley, Warren E., The burning temperature of limestone, pp. 68–78.
Emley, Warren E., Tests of lime, pp. 192–199.
Fippin, Elmer O., Some phases of the relation of lime to soil improvement, pp. 161–170.
Hopkins, Cyril G., Soil fertility and its relation to continued national prosperity, pp. 136–150.
Lazell, E. W., Tests of cement-lime mortars, pp. 221–241.
Spackman, Henry S., The possible effect of Alca lime plasters and cements on the future of the lime trade, pp. 6–12.
Warner, Irving, The position of lime in the chemistry of the soil, pp. 171–182.
Whyte, G. W., The theory and phenomena of the gas producer as a piece of apparatus, and as applied to the limekiln, pp. 94–106.
Wig, Rudolph J., The use of hydrated lime in Portland cement mixtures, pp. 213–220.

SAND-LIME BRICK.

By Jefferson Middleton.

INTRODUCTION.

The sand-lime brick industry, as shown by the figures which follow, was in a prosperous condition during the year 1910, and showed a slight increase in value of product over that of 1909. Two more plants reported in 1910 than in 1909, making a total of 76, as compared with 94 in 1907, the year of maximum activity.

The process of making sand-lime brick was invented in Germany, where it probably has had its greatest development; hence interest may be found in the following translation of an article in the Chemiker Zeitung, which shows some of the requirements for entering the association of manufacturers of sand-lime products in Germany and also some of the requirements of the building regulations of that country.

CONVENTION OF THE UNION OF SAND-LIME BRICK MANUFACTURERS IN BERLIN, FEBRUARY 24-25, 1911.[1]

REPORT OF THE BUSINESS COMMITTEE ON THE TRANSACTIONS OF THE UNION IN 1910.

On the motion of the present secretary, G. Beil, who also performed all the preliminary work, 26 sand-lime brick manufacturers met together on December 10, 1900, at the Architect House in Berlin and organized the present union. That so large a number of manufacturers still remain outside the union to-day is due to the fact that no manufacturer is admitted to membership who has not furnished satisfactory proof that his product comes up to the required standard of a minimum crushing strength of 140 kilograms per square centimeter. Certain requests for admission during the last year have had to be refused on this ground.

In the "Rules and regulations governing high buildings, building materials, and the bases of calculation for the static investigation of high buildings," published by the minister of public works January 31, 1910, it is stipulated that a weight of 1,800 kilograms per cubic meter shall be required for sand-lime brick, while only 1,600 kilos per cubic meter are required for brick in mortar. The union memorialized the ministry of public works in regard to this requirement, which, through disregard of present conditions, is likely to injure the sand-lime brick industry severely, and also addressed petitions to other public bodies which had published similar ordinances. So far, however, there has been no result. The injurious effect of the ordinance is particularly evident in cases where the static computation has been made for brick and then sand-lime brick is substituted, as the static computation has then to be made all over again. It has been demonstrated by experiments in the royal material-testing office, and also by weighings made under the direction of the union, that the ministerial decree is without any justification so far as the various manipulations of stone weight are concerned and completely upsets present conditions. With the exception of Berlin, where especially light bricks come on the market, the weight of burned brick is equal to that of sand-lime brick or even considerably heavier.

According to reports of Surveyor of Public Buildings Beckerhaus, Greifenhagen, in Pomerania, seems to have found in sand-lime brick a building material which will resist shining soot (glanzruss). Three years ago an inn was built in Greifenhagen, in which sand-lime brick was used for everything but the lining of the chimney flues, which were built of brick because at that time the question whether sand-lime brick was equally resistant to fire had not been settled. In spite of the fact that lignite

[1] Chem. Zeitung No. 30, 1911, p. 267.

briquets were burned, shining soot was found in the flues in a short time, and the flue bricks were permeated as high as the rafters of the ground floor. When the flues were pulled down it was found, however, that the sand-lime brick were entirely unharmed and white in color, in spite of the fact that the brick lining was only 12 centimeters (about 4.8 inches) thick. If this experience is repeated elsewhere the fact will be established that sand-lime brick is the best building material to withstand shining soot. The facts given above also show that shining soot forms when lignite briquets are used, although the formation of this substance is generally ascribed to the burning of nitrous peat.

PRODUCTION.

The following table shows the production of sand-lime brick in the United States from 1903 to 1910, inclusive:

Value of production of sand-lime brick in the United States, 1903–1910.

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	1910	76	1,169,153

This table shows that the value of this product rose rapidly until 1907, the year of maximum value of production and also of the largest number of operating plants. The year 1910 showed only a slight increase over 1909 in value of product, 1.61 per cent, but did not reach the figures of 1907, which is the maximum, by $56,616.

The following tables show the production of sand-lime brick in 1909 and 1910, by States and kinds:

Production of sand-lime brick in the United States in 1909, by States and kinds.

State.	Number of operating firms reporting.	Common brick.		Front brick.		Fancy brick.		Miscellaneous value. [a]	Total value.
		Quantity (thousands).	Value.	Quantity (thousands).	Value.	Quantity (thousands).	Value.		
Arkansas, Kansas, Nebraska, North Dakota, South Dakota, and Texas	8	17,277	$134,542	386	$3,935				$138,477
California	3	([b])	([b])	([b])	([b])				30,056
Colorado, Idaho, Montana, and Washington	6	4,734	42,426	3,693	62,646	([b])	([b])		105,734
Florida	6	11,466	71,748	([b])	([b])			$550	77,076
Georgia, Kentucky, Mississippi and Ohio	6	9,938	60,771						60,771
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
Minnesota	5	18,525	98,022	1,425	14,870	([b])	([b])		113,069
New Jersey	3	([b])	([b])	([b])	([b])				21,925
New York	7	11,716	77,842	1,216	12,120	([b])	([b])		90,402
Pennsylvania	4	10,441	59,453	([b])	([b])				62,255
Wisconsin	3	3,803	26,045	([b])	([b])				29,345
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 price 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.

Production of sand-lime brick in the United States in 1910, by States and kinds.

State.	Number of operating firms reporting.	Common brick.		Front brick.		Fancy brick.		Miscellaneous value.[a]	Total value.
		Quantity (thousands).	Value.	Quantity (thousands).	Value.	Quantity. (thousands).	Value.		
California	5	3,094	$27,368	1,097	$16,144				$43,512
Colorado, Idaho, Montana, and Washington	6	5,786	52,724	2,676	38,054	105	$3,757		94,535
Delaware, District of Columbia, Maryland, North Carolina, and Virginia	7	3,224	25,751	(b)	(b)			(b)	42,455
Florida	4	12,685	77,950	(b)	(b)				85,450
Georgia and Mississippi	3	3,606	20,489	(b)	(b)				24,146
Indiana	5	13,869	63,134	(b)	(b)				63,534
Iowa	3	(b)	(b)	(b)	(b)	(b)	(b)	(b)	31,269
Kansas, Nebraska, North Dakota, South Dakota, and Texas	7	17,440	132,827	831	9,289				142,116
Kentucky and Ohio	3	5,232	32,050						32,050
Michigan	10	37,648	218,627	(b)	(b)				240,649
Minnesota	5	22,444	145,705	544	7,345	(b)	(b)		154,250
New Jersey	3	1,512	9,254	(b)	(b)	(b)	(b)		23,811
New York	7	14,647	89,150						89,150
Pennsylvania	4	11,854	72,827						72,827
Wisconsin	4	4,426	29,055	(b)	(b)				29,399
Other States[c]		3,513	26,906	6,156	52,342	118	4,113	$14,292	(d)
Total	76	160,980	1,023,817	11,304	123,174	223	7,870	14,292	1,169,153
Average price per M			$6.36		$10.90		$35.29		

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 1910, as shown by these tables, $18,573, or 1.61 per cent. In 1909 the increase was $120,881, or 11.74 per cent. In order to avoid disclosing individual operations, it has been necessary to group certain States. In 1910, as in 1909, reports were received from operating plants in 28 States; in 1908 from 30 States. Arkansas, which reported a product for 1909, reported none for 1910, and the District of Columbia entered as a producer in 1910.

Michigan led in 1910, as for several years, and reported products valued at $240,649; this was a gain of $22,423, or 10.28 per cent, over 1909. Michigan's product constituted 20.58 per cent of the total value of all sand-lime products in 1910, and 18.97 per cent of the total of 1909. Minnesota was the State to show the largest increase—$41,181, or 36.42 per cent—and was second in value of product in both years; New York was third in both years, Florida fourth, and Pennsylvania fifth. Of the States for which totals are given Indiana showed the largest proportional gain, 93.70 per cent. Of these States only 2 showed a decrease in value of product, Iowa, $16,941, or 35.14 per cent; and New York, $1,252, or 1.38 per cent. Michigan continued to have the largest number of plants, 10 in 1910, a decrease of 1 from 1909 and the same number as for 1908. New York was next to Michigan, with 7 plants in 1910, the same number that reported in 1909 and 1908.

The average price per thousand received for common sand-lime brick was $6.36 in 1910, as compared with $6.39 in 1909, and $6.33 in 1908; for front brick $10.90, as against $11.98 in 1909, $12.16 in 1908, and $10.96 in 1907. In 1910 common brick yielded 87.57 per cent of the value of all products; front brick, 10.53 per cent; and all other products 1.90 per cent. In 1909 those percentages were 77.12, 13.35 and 9.53, respectively.

SLATE.

By A. T. Coons.

PRODUCTION.

GENERAL CONDITIONS OF THE INDUSTRY.

The statistics of the production of slate in 1910, as presented in this report, 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 1910 the output of slate, as reported to the United States Geological Survey, increased in value $795,341, from $5,441,418 in 1909 to $6,236,759 in 1910. Notwithstanding this increase, the total value for 1910 did not equal the value for 1908, which was $6,316,817, the largest production ever reported for slate.

The increase in the production of slate for all uses was general in 1910, and although all the producing States did not show an increased output, the demand generally reported by the quarrymen was about equal to that of 1909. Prices were about the same or were possibly a little lower. There were strikes in some regions, notably in Virginia, and there were many slides in the quarries and some quarry accidents.

In 1910 ten States contributed to the commercial output of slate in the United States. These States, named in rank of output, were Pennsylvania, Vermont, Maine, Virginia, New York, Maryland, New Jersey, California, Georgia, and Tennessee. In 1909 the producing States ranked as follows: Pennsylvania, Vermont, Maine, Virginia, Maryland, New York, California, New Jersey, and Georgia.

New York displaced Maryland and New Jersey displaced California in 1910. Georgia, Maine, New Jersey, Pennsylvania, and Vermont showed increased output; California, Maryland, New York, and Virginia decreased in value of output. Tennessee reported a commercial output for the first time since 1904.

ROOFING SLATE.

About 78 per cent of the value of the slate production in the United States in 1910 was represented by slate for roofing; and the roofing slate output from Pennsylvania and Vermont represented, respectively, about 58 and 33 per cent of the total value of the roofing slate output. Besides roofing slate Pennsylvania and Vermont produce also mill stock; practically the only use of slate from the other producing States is for roofing.

In 1910 the output of roofing slate was reported as 1,260,621 squares, valued at $4,844,664, the average price per square being $3.84; in 1909 there were reported 1,133,713 squares, valued at $4,394,597, with an average price per square of $3.87, an increase in 1910 of 126,908 squares in quantity and of $450,067 in value, but a decrease of 3 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 generally prepared for special work.

MILL STOCK.

The mill stock is nearly all furnished by the quarries of Pennsylvania, Vermont, and Maine. In 1909 Maine and Vermont showed a decided increase in the quantity and value of this material, while Pennsylvania showed a decrease in production. In 1910 all three States showed an increase, the increase in Pennsylvania being much larger than in the other States. The value of mill stock, including slate sold for all purposes other than roofing, increased from $1,046,821 in 1909 to $1,392,095 in 1910, a gain of $345,274.

Both the quantity and the value of mill stock, exclusive of slate reported as sold as blackboards and school slate, increased from 5,112,894 square feet, valued at $876,089 in 1909, to 5,181,498 square feet, valued at $999,098 in 1910, an increase of 68,604 square feet in quantity and of $123,009 in value. The average price per square foot increased from 17 cents in 1909 to 19 cents in 1910.

Mill stock includes blackboards, school slates, flooring, wainscoting, vats, tiles, sinks, laundry tubs, grave vaults, sanitary ware, refrigerator shelves, flour bins and dough troughs for bakeries, electrical switchboards, mantels, hearths, well caps, and billiard, laboratory, kitchen, and other table tops. This material is made in the form of slabs, from 1 inch to 3 inches or more thick, and is sold at prices ranging from 4 cents to 50 cents per square foot, according to the size, thickness, and quality of the slate and to the work done on it. It is sold in rough slabs by the quarrymen to the slate mills, or is milled by quarrymen operating their own mills.

It is noteworthy that quarries in Lehigh and Northampton counties, Pa., report the only stock produced for school slates and blackboards. These quarries can best produce this material on account of the unusually fine cleavage of their slate and the thickness and size of the beds. The quantity and value of slate produced for these uses increased in 1910.

SLATE FOR OTHER USES.

A quantity of slate reported as applied to other uses consists chiefly of slate for structural material, flagging, and road repairing, and amounts to a very small proportion of the total output. This slate is generally sold from the waste heaps of the quarry.

More than usual attention has lately been given to the use of the waste material from slate quarries, which amounts to about 80 per cent of the slate quarried. This waste has until recently always been regarded as a useless but unavoidable product of the quarry, expensive yet necessary, and so far no extensive use has been found for it. Within the last few years, however, it has been suggested that the quarrymen, instead of trying to find use for so large a quantity of waste material, might devise some means to prevent its formation and accumulation. To reduce materially the amount of this waste it is necessary to employ better methods of quarrying—methods that will get out the largest quantity of good material with the smallest quantity of waste. Attention should also be given to economies in the treatment of slate after quarrying, both in making roofing slate and in preparing mill stock. By the method of slate quarrying most generally employed in this country, heavy, irregular masses of rock have been blasted or drilled out without careful attention to the use of such machinery as might obtain blocks of stone better fitted for use for roofing or in mills, and also without making provision for better quarry conditions. Hence much labor and much handling of material is necessary before the slate can finally be marketed. During the last two years, however, some quarries have been opened for the special purpose of getting out stone with modern machinery and working up the slate in such a way as to obtain from it all possible material of value.

The slate quarries in this country are all worked from the surface, being stripped on top and thus worked down to the slate from above. Some experiments are, however, being made, it is stated, to work the slate from below with modern machinery and to use the waste slate to fill up holes left by the removal of the good slate.

In Stone for October, 1910, George Barnam [1] writes on the conditions of the slate industry under the title "Mechanical slate splitting and slate veneers," from which the following is extracted:

[1] Barnam, George, Mechanical slate splitting and slate veneers: Stone, October, 1910, p. 516.

It is a fact everywhere conceded that the slate industry is in a far from satisfactory condition not only in America, but in every country where slate is produced. This is the more to be wondered at because there is a tremendous amount of new building, and nothing has ever been discovered that will compare with slate as a roofing material. In studying the causes of this condition of affairs the candid observer inevitably arrives at certain conclusions. These are, first, that the depression is largely due to a lack of progressive methods in the quarrying, manufacture, and marketing of slate, and, second, to what has heretofore been held to be an ineradicable difficulty, namely, the tremendous proportion of waste in the production of slate. In the entire process, from the breaking loose of the masses of slate rock from the veins to the finished product of roofing slate or milled slabs, a proportion varying from 50 to 90 per cent goes to the dump heap. Indeed, there are quarries where the proportion of waste rises as high as 93 per cent. The evils of such wasteful methods are apparent. There is the cost of frequent handling of a heavy material that has eventually to be thrown away. There is the carrying of the workings to such depth that the raising of the rock becomes a slow and expensive process. Finally, there is the disposition of the waste. Every slate quarry is surrounded with mountains of refuse rock that seriously hamper operations and often prevent further development work.

It is well to consider the causes of the waste in order to understand where remedies can best be applied. The first process of all, the quarrying of the rock, is very wasteful. Masses of rock, generally of such large size that they can not be raised from the pit, are broken loose from the beds by crude methods, usually by drilling and blasting. This results in rough and angular blocks from which a large proportion has to be trimmed off and thrown away. Then the blocks must be broken into convenient size to go to the slate makers or the mill, and further loss results. In very few quarries are channeling machines used. Doubtless this is because most channelers are cumbersome and heavy machines, scarcely suited for the working of rock of so friable a nature as slate. The first step in revolutionizing slate quarrying should be the use of a cutting machine specially adapted to slate. We are aware that slate channelers are made at present. If they cut out rectangular blocks, it is positively criminal that they have not been more widely adopted. If they fail in any way to give the relief sought, American ingenuity should be set at work modifying and improving them. The coal-mining industry, which is wideawake and progressive, uses mechanical coal cutters, so the trouble in the slate trade seems to be not with the machinery makers, but with the quarrymen themselves. The splitting of slate into roofing is also productive of a great amount of waste. There has been no improvement in this line in the hundreds of years since slate has been used for roofing purposes. The implements are a broad chisel and a mallet in the hands of a workman.

Still a third cause of waste is a failure to provide any suitable use for slate that is not adapted for making roofing or for milling into large slabs. If any method can be found for utilizing comparatively small pieces of slate, the waste piles will dwindle and a new source of income will be had.

Incidentally, there are two more prolific sources of waste, but as these are foreign to the scope of this article they need only to be touched upon here. The first of these is the system on which most quarries are operated. This is generally by lease. The lessee wishes to get the largest returns in the shortest time. In the parlance of the trade, he "robs the quarry"; that is, he works up only the choicest of the slate rock, and ruthlessly destroys the rest. The second evil is specialization. The making of roofing slate affords the quickest and surest return. Therefore a quarry is given up to this alone. No rock is used that can not be split into roofing. It is well known that when a quarry block of slate has been frozen or when the sap has evaporated it can not be split. Therefore it is thrown on the dump heap. At every roofing quarry there are thousands of tons of rock in the waste piles that would make superb mill stock. A small mill at every slate quarry would not only greatly reduce the proportion of waste, but would also yield a good income.

Mr. Barnam further states that—

Mr. Vincent F. Lake, an engineer and inventor, has made serious study of three points of the slate question—the splitting of slate, the use of slate for new and wider purposes, and the utilization of slate waste.

As the first step in the solution of the problem, Mr. Lake invented an automatic mechanical slate splitter. This statement will immediately call out a cry of protest from every practical slate man, for if there is one belief that is thoroughly ingrained it is that it is absolutely impossible to split slate by mechanical means. The reason for this belief is the peculiar nature of fissility in slate. The cleavage planes in slate are not absolutely smooth, as in mica, for instance. They overlap and cling one to the other, as one can see by examining the wavy surfaces of split slate. In order to make a break it is necessary to "favor" the slate; that is, to pry gently and allow the springiness of the slate to aid in developing the cleavage. The great trouble with all attempts to use mechanical splitters heretofore has been in the rigidity of the mechanism. A rigid knife will merely crush the slate instead of splitting it. Because of pending patents in foreign countries it is impossible to give a detailed description of this new machine. It must suffice to say that the inventor has succeeded in eliminating rigidity. In place of this there is a flexibility that gives a remarkable simulation of the operation of splitting slate by hand. It only remains to add that this is not all theoretical. The appliance has been tried and found to do all that is claimed for it. What is more, it is possible by the use of the automatic machine to split slate as thin as one thirty-second of an inch, or even thinner, something that could never be done by hand. The production of extremely thin plates of slate, or veneers, as they are to be called, will greatly extend the field of usefulness for slate.

Heretofore "overlapping slate" has been the only application of this material to roofing purposes. Of course, where this style of roofing is desired the mechanical splitter will be available. It is claimed that this will produce roofing slate of full thickness four times as rapidly as it can be made by hand, with a consequent reduction of cost. The machine requires one man to operate it, and a boy to bring the slate to the machine and take away the finished product. It should be said that the appliance requires that one end of the block of slate to be split should be sawed. As a matter of convenience, in order to hold the block upright in the machine and avoid the necessity for adjustment, it is proposed to saw both ends.

What is believed to be a great possibility is a substitute for overlapping slate as now laid. Successful experiments have been made in this line. Veneers of slate from one-sixteenth to one thirty-second of an inch in thickness are backed up with slate concrete, which may be reenforced with steel or not, as desired. This gives a total thickness to the roofing of from five-sixteenths to three-eighths of an inch as a minimum. This can be made to simulate overlapping slate perfectly, but it would differ from the latter in being made in advance in slabs of 10 square feet and in having absolutely water-tight joints. This would enable the roof to be flat, and the pitch now required in slate roofs could be dispensed with. The weight of such a roof would range from 4 to 6 pounds per square foot as against 6½ pounds for overlapping slate. From experiments that have been made it is believed that such a roof would exceed in strength almost any kind that is now laid.

Another use of the slate veneering would be to help out the present ready-made flexible roofings, whether the surfaces are now painted, sanded, pebbled, or graveled. For such purposes the present flexible bases would be used, but as a substitute for the surface treatment the slate veneers would be applied. In most of these ready-made roofings, pitch, or tar, highly inflammable, are used. In place of these slate would afford material at once fireproof and absolutely impervious to moisture.

Still another use for the slate veneers is as a facing for concrete bricks. The great objection that is now urged to concrete bricks is that they are extremely porous. In order to prevent moisture from penetrating a wall of concrete bricks, it is necessary to lay them in double courses with an air space between, binding the courses together with metal ties for security. It is apparent that if a concrete brick has a facing of slate it will be absolutely impervious to moisture from the outside, providing it is laid with waterproof cement. If the body of the brick be made of slate concrete, instead of the ordinary sand concrete, it will be waterproof throughout. The ordinary cement block can be so treated as to prevent the passage of moisture completely through it. This is done by the injection into it in the process of manufacture of one or more thin sheets of slate concrete.

There are many other possible uses of slate veneering that can only be hinted at here. One of these is as a basis for waterproof plaster. In this use of slate veneer the plaster is protected from penetration by moisture from the back. Another use lies in its substitution for paint, whether upon wood or metals. Its application to metal beams and structural material in a multitude of places would make it unnecessary to use paint or to be at great expense for future protection. It would be especially adapted to waterproofing subways and protecting steel structures from corrosion, whether subsequently covered with concrete or left exposed.

Mention has been made of slate concrete. Heretofore slate has been supposed to be unfitted for concrete making, but by subjecting it to certain treatment, which can not be made public until patents have been perfected, it is found to yield a strong and waterproof concrete. Material is crushed between rollers instead of being broken in the usual way.

It will be seen that these various processes adapt slate to many new purposes, make use of smaller sizes of slate that are now rejected, and utilize directly the dump heaps. There should be a chance here to revolutionize the entire industry.

This article seems to present at least a partial solution of the slate-waste problem and it is hoped that successful results will follow.

In connection with slate veneers and the use of slate on flat roofs, which have heretofore been almost entirely made of concrete, sheet metal, asphalt, gravel, and flat tiles, it is interesting to note that the Inlaid Slate Company, of Bangor, Pa., has been making from the waste slate of the Bangor quarries, a slate roofing for flat roofs or roofs with but a slight incline that is no longer in the nature of an experiment, but has been practically used on a large number of buildings, such as factories, gymnasiums, train sheds, office buildings, power houses, apartment houses, private dwellings, etc., and has been found extremely satisfactory.

The process of manufacture is as follows:

The slate is sawed into 3-inch squares and then embedded in a mixture of high-melting asphalt and sand, with a backing of roofing felt. The material is then cut into units measuring 12 by 15 inches, packed into crates containing 18 units, and is ready for shipment. The units are mopped onto a prepared waterproof surface with hot high-melting asphalt laid thick enough to properly embed the units, which are trodden into the hot asphalt as soon as it is applied to the surface. Eighty units are required to cover a square (100 square feet) of roofing. This process is said to give a most satisfactory roofing slate, comparatively light in weight, strong, easily cleaned, and adapted to light frame construction, also to concrete or heavy material. This roof may also be used for all purposes for which an extra unroofed floor would provide. Such a roof, like other slate roofs, is a protection against fire. The small size of the slate pieces serves to make the roof stronger, allows of flexibility, which enables the units to conform to the shape of the roof and also lessens the trouble by contraction and expansion suffered by heavy metal and tile roofs.

QUANTITIES AND VALUES.

The following table shows the quantity and the value of roofing, mill, and other slate quarried in the United States in 1909 and 1910, by States and uses:

Quantity and value of roofing, mill, and other slate produced in the United States in 1909 and 1910, by States and uses.

1909.

State.	Number of operators.	Roofing slate. Number of squares.	Roofing slate. Value.	Roofing slate. Average price per square.	Mill stock. Manufactured. Quantity.	Mill stock. Manufactured. Value.	Mill stock. Rough. Quantity.	Mill stock. Rough. Value.	Mill stock. Total. Quantity.	Mill stock. Total. Value.	Other.	Total value.
					Square feet.		Square feet.		Square feet.			
California	1			$6.56								(a)
Georgia	1			5.75								(a)
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								(a)
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	b 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 c		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

1910.

State.	Number of operators.	Roofing slate. Number of squares.	Roofing slate. Value.	Roofing slate. Average price per square.	Mill stock. Manufactured. Quantity.	Mill stock. Manufactured. Value.	Mill stock. Rough. Quantity.	Mill stock. Rough. Value.	Mill stock. Total. Quantity.	Mill stock. Total. Value.	Other.	Total value.
California	1			$7.50								(a)
Georgia	2			6.05								(a)
Maine	6	16,708	$99,023	5.93	385,307	$149,982			385,307	$149,982		$249,005
Maryland	4	14,529	77,791	5.35							$782	78,573
New Jersey	2			4.50								(a)
New York	6	17,618	84,089	4.77			2,933	$733	2,933	733		84,822
Pennsylvania	104	777,190	2,809,593	3.62	3,036,393	508,461	440,133	31,111	3,476,526	539,572	d 391,641	3,740,806
Tennessee	1			4.50								(a)
Vermont	48	395,640	1,585,324	4.01	1,085,894	278,202	230,838	30,609	1,316,732	308,811	524	1,894,659
Virginia	7	31,787	148,721	4.68								148,721
Other States c		7,149	40,123								50	40,173
Total	181	1,260,621	4,844,664	3.84	4,507,594	936,645	673,904	62,453	5,181,498	999,098	392,997	6,236,759

a Included in Other States.
b 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.
c Includes in 1909, California, Georgia, and New Jersey; in 1910, California, Georgia, New Jersey, and Tennessee.
d Composed of 5,610,518 school slates, valued at $47,075; 2,821,689 square feet of blackboard material, valued at $334,070; and $10,496 for slate used for structural and other purposes.

The following table shows the total value of the slate produced in the United States from 1906 to 1910, inclusive:

Value of slate produced in the United States, 1906–1910, by States.

State.	1906	1907	1908	1909	1910
Arkansas	$5,000	$8,500	$2,500		
California	80,000	60,000	60,000	(a)	(a)
Georgia	5,000			(a)	(a)
Maine	238,681	236,606	213,707	$227,882	$249,005
Maryland	130,969	116,060	102,186	129,538	78,573
New Jersey		8,000	} 130,619	(a)	(a)
New York	72,360	83,485		107,436	84,822
Pennsylvania	3,522,149	3,855,640	3,902,958	2,892,358	3,740,806
Tennessee					(a)
Vermont	1,441,330	1,477,259	1,710,491	1,841,589	1,894,659
Virginia	172,857	173,670	194,356	180,775	148,721
Other States [c]				61,840	40,173
Total	5,668,346	6,019,220	6,316,817	[b] 5,441,418	[c] 6,236,759

[a] Included in Other States.
[b] Includes California, Georgia, and New Jersey.
[c] Includes California, Georgia, New Jersey, and Tennessee.

The following table shows the value of slate produced for roofing and for mill stock from 1906 to 1910, inclusive:

Value of roofing slate and mill stock, 1906–1910.

	Roofing slate.		Value of mill stock.	Total value.
	Number of squares.	Value.		
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
1910	1,260,621	4,844,664	1,392,095	6,236,759

PRICES.

The following table shows the average price of roofing slate per square since 1903:

Average annual price per square of roofing slate for the entire country.

1903	$3.88	1907	$3.77
1904	3.78	1908	3.89
1905	3.69	1909	3.87
1906	3.66	1910	3.84

IMPORTS.

Practically no slate is imported into the United States. In 1909 slate valued at $7,872 was imported in the form of mantels, chimney pieces, roofing slate, slabs, etc.; in 1910 the importations were valued at $4,127, and included the same articles.

EXPORTS.

In comparison with the total output, the value of roofing slate exported from this country in 1910 was very small, and the figures were not kept separate from the exports of other varieties of stone. The exports in 1909 amounted to $209,383.

SLATE INDUSTRY BY STATES AND LOCALITIES.

Arizona.—The undeveloped deposit in this State is north of Phoenix, in Maricopa County. The deposit has never been developed. This slate is bluish gray with a lustrous surface. The company interested in the deposit is the Phoenix Slate Co., of Phoenix, Ariz.

Arkansas.—The slate deposits of Arkansas occur in parts of an area about 100 miles long and 12 to 20 miles wide in the west-central part of the State, lying a little southwest of Little Rock and including portions of Pulaski, Saline, Garland, Montgomery, and Polk counties. Owing to lack of transportation and lack of capital for complete development, very little of the slate has been put on the market. Considerable activity has been shown during the year 1910. New companies have been formed, and it is possible that the enterprise may become a commercial one.

The slate found in these deposits includes black, gray, and green slates, as found distributed in the deposits of the principal producing localities. The chief use to which the slate has been put is for electrical purposes, but it is said to be equally well adapted for roofing.

Full descriptions of these deposits may be found in United States Geological Survey Bulletins 275 [1] and 430,[2] and in a report by the Arkansas Geological Survey.[3]

California.—Work on slate deposits in this State in 1910 has been confined to the operations of the Eureka Slate Co., at Slatington, Eldorado County. There was a small decrease in the output for 1910, but the quarry operations by this company were discontinued for a time in order to enlarge the quarry to meet the increased demand. The slate from this region is used entirely for roofing, and is a black slate of fine texture. Some grayish-green slate is also found in this deposit.

Although the slate property of the Pacific Slate Co., at Merced, Merced County, has not been entirely abandoned, no work has been done there for several years.

Colorado.—Development work only was done in 1910 by the Colorado Slate Co. at the black slate deposit at Marble, Gunnison County. T. Nelson Dale, of the United States Geological Survey, makes the following report after an examination of a small specimen of black slate from this quarry:

The slate has an extremely dark bluish gray color. To the unaided eye its texture is fine with slightly uneven, lusterless cleavage surface. It contains carbonaceous matter and extremely little magnetite. The sawn edge shows some pyrite. It effervesces with cold, dilute hydrochloric acid, is sonorous, and has a medium grade of fissility.

Under the microscope it shows a matrix of muscovite (sericite) with feeble aggregate polarization. The cleavage is rendered uneven by alternating beds of fine and coarse particles, which are parallel to the cleavage. Carbonate is very abundant and helps to obscure the aggregate polarization. Pyrite is plentiful in

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[1] Dale, T. Nelson, and others, Slate deposits and slate industry of the United States; Bull. U. S. Geol. Survey No. 275, 1906.
[2] Purdue, A. H., Slates of Arkansas: Bull. U. S. Geol. Survey No. 430, 1910, pp. 317–334.
[3] Purdue, A. H., The slates of Arkansas; Geol. Survey Arkansas, 1909.

spherules and irregular particles up to 0.16 millimeter across. Opaque carbonaceous matter also abounds and there are several forms of organic origin. Rutile needles are very scarce or absent. Quartz grains measure up to 0.03 millimeter in diameter.

The constituents of this slate, in descending order of abundance, appear to be muscovite, carbonate, quartz, carbon, kaolin, chlorite.

As shown by the defective aggregate polarization and confirmed by the scarcity of slate needles, this is an incompletely formed mica slate and it also belongs to the fading series. Its strength should be tested.

Georgia.—Slate was marketed from two deposits in Georgia during 1910, and the value of the product, which was all roofing slate, showed an increase in 1910 over 1909. One deposit at Rockmart, Polk County, has been under development for several years, with local sales, and one company, Ellis Davis & Son, reported as operating in 1910. In 1910, for the first time, operations were reported from Bolivar, Bartow County, Ga., by the Georgia Green Slate Co., which began business in January, 1910, and stated that it found the demand more than it could supply for the first year. An analysis of this slate, as submitted to this office by the company, made by Dr. Edgar Everhart, chemist of the Geological Survey of Georgia, is as follows:

Analysis of slate from Bolivar, Bartow County, Ga.

Water (H_2O)	0.14
Loss on ignition less carbonic acid (CO_2)	4.76
Sodium oxide (Na_2O)	1.26
Potassium oxide (K_2O)	2.83
Calcium oxide (CaO)	1.22
Magnesium oxide (MgO)	2.96
Alumina (Al_2O_3)	21.61
Ferric oxide (Fe_2O_3)	1.36
Ferrous oxide (FeO)	5.97
Manganese oxide (MnO)	.05
Titanium oxide (TiO_2)	.74
Sulphur S	.35
Phosphorus pentoxide (P_2O_5)	.02
Carbon dioxide (CO_2)	.91
Silica (SiO_2)	56.02
	100.20
Less oxygen	.09
	99.11

A specimen of this slate was examined by T. Nelson Dale, of the United States Geological Survey, and showed the following characteristics:

The slate is of light greenish gray color, with some fine irregular streaks of dark bluish green crossing the cleavage. It has a very fine, even, and somewhat lustrous cleavage surface, shows a little pyrite on the sawn edge, and contains extremely little magnetite. It scarcely effervesces with cold, dilute hydrochloric acid, is sonorous, and has a superior grade of fissility.

Under the microscope it shows a matrix of muscovite (sericite) with marked aggregate polarization and a fine and regular cleavage, also abundant rutile needles. It contains a little carbonate in fine particles or rhombs and a little pyrite in spherules and irregular grains. There are lenses of chlorite up to 0.34 by 0.009 millimeter. The chlorite scales measure up to 0.009 millimeter and the quartz grains to 0.047 millimeter.

The constituents of this slate, in descending order of abundance, appear to be muscovite, quartz, chlorite, carbonate, pyrite, magnetite.

This is a true mica slate of fine fissility and attractive color. Although the amount of carbonate in it is not as large as that in the "sea-green slate" of Vermont it is probably sufficient to produce in time some discoloration.

Maine.—The deposits of slate operated commercially in Maine are in the central part of the State, in Piscataquis County, near the towns of Monson, Blanchard, and Brownville.

No development has ever been made at the deposits in Somerset County. The slate from the Maine quarries is a very dark gray or black slate and is used both as a roofing slate and for mill stock, including slate for all kinds of electrical work and for structural purposes.

The total value of the slate output in Maine in 1910 was $249,005, a gain of $21,123 over 1909, when the value was $227,882. The increase was in quantity and value of the milling stock, as the roofing slate decreased in both quantity and value. In 1910 there was reported 385,307 square feet of mill stock, valued at $149,982; in 1909, 372,229 square feet, valued at $126,017, an increase for 1910 of 13,078 square feet in quantity and of $23,965 in value. This was all reported as manufactured, and the average price per square foot was 39 cents in 1910 and 34 cents in 1909. The roofing slate decreased from 18,024 squares, valued at $101,865, in 1909, to 16,708 squares, valued at $99,023, in 1910—a decrease of 1,316 squares in quantity and of $2,842 in value. The average price per square was $5.93 in 1910 and $5.65 in 1909.

Maryland.—The slate deposits at Cardiff, Harford County, furnish, at present, the entire output of Maryland slate. These deposits are on the same belt as those of Delta, York County, Pa., and are known to the trade as "Peach bottom" slate. This slate is of a very dark bluish-gray color, and is used almost entirely for roofing. Other deposits of slate in Maryland, not developed or in course of development, are in Montgomery County, and near Woodsboro and Thurston, Frederick County.

A new operation was reported at Woodsboro, but so far only development work has been done here by the Washington-Woodsboro Slate Co. The slate output of Maryland decreased from a total value of $129,538, in 1909, to $78,573, in 1910, a loss of $50,965. The roofing slate decreased from 22,563 squares, valued at $128,227, in 1909, to 14,529 squares, valued at $77,791, in 1910, a loss of 8,034 squares and of $50,436. The average price per square was $5.68 in 1909 and $5.35 in 1910. There was a small decrease in the value of slate used for other purposes than for roofing. Two of the quarries active in 1909 were idle in 1910, and of the other quarries one reported operations for only part of the time.

Massachusetts.—Massachusetts was one of the first States in which slate quarries were opened in the United States—at Lancaster, Worcester County, but these have long since been discontinued—as a source of slate for roofing and also for mineral paint. Slate also occurs in Massachusetts in Middlesex County, near Cambridge and Somerville, but it is not sufficiently fissile for use as roofing slate or mill stock, and its use is confined entirely to crushed stone, and therefore is not considered in this report.

Minnesota.—A deposit of slate said to be suitable for roofing occurs near Thompson, Carlton County, Minn., but the quarries are abandoned, and no slate has been taken out for several years.

Nevada.—So far as known to this office, no development work has been done on the deposit of "black" slate in Humboldt County, Nev., described in the report on the slate industry for 1908.

New Jersey.—The slate produced in New Jersey is from Newton and La Fayette, Sussex County. Quarries have, however, been operated in Warren County, near the Delaware Water Gap, but not recently.

The New Jersey slate is a very dark gray or "black" slate used entirely for roofing. The output for the State increased somewhat for 1910. The average price per square was $4.50 in 1910 as compared with $4.39 in 1909.

New York.—Although slate has been quarried in Rensselaer County, N. Y., the quarries did not prove to be of economic value and were abandoned, and only the slate from Washington County, in the towns of Granville, Whitehall, and Hampton is used commercially. The slate from this county is either of a reddish brown color, known to the trade as "red" slate, or of a bright greenish color. The total value of the New York slate output decreased from $107,436 in 1909 to $84,822 in 1910, a loss of $22,614. Most of the New York slate is used for roofing, and decreased from 18,098 squares, valued at $106,175, in 1909, to 17,618 squares, valued at $84,089, in 1910, a decrease of 480 squares in quantity and of $22,086 in value. The average price per square was $5.70 in 1909 and was $4.77 in 1910. This State more than any other varies in yearly average price of output, and this is due to the fluctuating demand and sale of the high-priced, specially prepared red slates. There was a slight increase in the quantity and value of mill stock sold. Two quarries reporting a production in 1909 were idle in 1910.

Pennsylvania.—There was an increase of $848,448 in the value of the Pennsylvania slate output in 1910 over that of 1909, the figures being $3,740,806 for 1910 and $2,892,358 for 1909. Notwithstanding this considerable increase the loss for 1909 of $1,010,600 as compared with $3,902,958 in 1908, was not covered in 1910, nor has the slate trade in general entirely recovered from the depression of 1908.

The value of the slate production in Pennsylvania in 1910 represented 59.98 per cent of the total value of the United States, as compared with 53.15 per cent in 1909, and 61.79 per cent in 1908. Pennsylvania slate is used both for roofing and for milling stock, and is quarried in Carbon, Lehigh, Northampton, and York counties. The slate from the Carbon and York County quarries is used only for roofing; Lehigh and Northampton counties furnish both roofing slate and milling stock.

T. Nelson Dale, of the United States Geological Survey, examined a specimen obtained from a drill core from an undeveloped deposit of slate at Derry Church, Dauphin County, Pa., with the following results:

The slate is of dark bluish gray color, with very fine, even, and somewhat lustrous cleavage surface. It shows pyrite on the sawn edge, is graphitic, contains no magnetite, and effervesces freely with cold, dilute hydrochloric acid. It is sonorous and has a superior grade of fissility.

Under the microscope it shows fine aggregate polarization and abundant rutile needles, much carbonate in rhombs and irregular plates up to 0.06 millimeter, also abundant pyrite in spherules from 0.004 to 0.017 millimeter in diameter, but mostly under 0.008 millimeter. The cleavage foliation is crossed by a fine zigzagging vein of calcite. It contains nodules of carbonate up to 0.1 by 0.04 millimeter and of chlorite up to 0.1 by 0.04 millimeter. The quartz grains measure up to 0.06 millimeter and there are a few prisms of black tourmaline.

Its constituents, in descending order of abundance, appear to be muscovite, quartz, carbonate, pyrite, chlorite, graphite, rutile, tourmaline.

This is a true mica slate of fine fissility but of the fading series. The cores show some variation at different depths in the abundance of carbonate veinlets and also in what appear to be "ribbons," but the general quality of the slate is the same.

In 1910 Pennsylvania produced 61.65 per cent of the total quantity and 57.99 per cent of the total value of roofing slate produced in the United States. Northampton County produced 70.27 per cent of the quantity and 72.48 per cent of the value of Pennsylvania slate output, and 43.32 per cent of the total quantity and 42.03 per cent of the total value for the United States. Lehigh County produced 27.89 per cent of the quantity and 24.84 per cent of the value of the Pennsylvania slate output, and 17.19 per cent of the quantity and 14.40 per cent of the value for the entire United States.

The average price per square of roofing slate in Pennsylvania in 1910 was $3.62, as compared with $3.86 in 1909, a decrease of 24 cents per square. Northampton County had an increase in average price per square, while in the other counties there was a decrease. The greater number of the operators reported demand and prices about the same as in 1909. Northampton and Lehigh County slate is also used for mill stock and is the only blackboard and school slate reported in the United States. York County produces the Peach Bottom slate and is on the same belt as the slate of Harford County, Md.

Besides leading in the production of roofing slate, Pennsylvania has a larger output of mill stock than any other State, producing in 1910, exclusive of blackboard stock and school slate, 54.01 per cent of the total value and 67.09 per cent of the total quantity of this material for the United States. The mill stock quarried in Pennsylvania, exclusive of school slates and blackboards, amounted to 3,389,119 square feet, valued at $441,464, in 1909, and 3,476,526 square feet, valued at $539,572, in 1910, an increase for 1910 of 87,407 square feet in quantity and of $98,108 in value. The average price per square foot of mill stock, both rough and manufactured, exclusive of blackboard and school slate, in Pennsylvania, was 16 cents in 1910 and 13 cents in 1909.

The material sold for blackboards increased from 1,095,540 feet, valued at $130,195, in 1909, to 2,821,689 square feet, valued at $334,070, in 1910, an increase of 1,726,149 square feet in quantity and of $203,875 in value. The average price of blackboard material was the same in 1910 as in 1909—11.8 cents per square foot.

The school-slate production reported increased from 3,650,831 slates, valued at $32,319, in 1909, to 5,610,518 slates, valued at $47,075, in 1910, an increase of 1,959,678 slates in quantity and of $14,756 in value. The average price of school slates was $8.39 per thousand in 1910 and $8.85 per thousand in 1909. The average size of slates sold is 7 by 11 inches.

The Pennsylvania slate is mostly of a dark gray or other dark color. Many of these dark slates, however, become somewhat lighter in color on exposure to the atmosphere.

The following table shows in detail the production of slate in Pennsylvania, by counties and uses, in 1909 and 1910:

Production of slate in Pennsylvania in 1909 and 1910, by counties and uses.

1909.

County.	Number of operators.	Roofing slate.			Mill stock.								Other (value).	Total value.
		Number of squares.	Value.	Price per square.	Manufactured.		Rough.		Blackboards.		School slates.			
					Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	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
1910.														
Carbon	1	14,291	$75,191	$2.25	....	....	....	....	....	....	....	....	....	$75,191
York	4			5.60										
Lehigh	43	216,743	697,964	3.22	294,730	$73,092	173,052	$18,578	1,522,741	$172,448	2,627,821	$22,429	$464	984,975
Northampton	56	546,156	2,036,438	3.73	2,741,663	435,369	267,081	12,533	1,298,948	161,622	2,982,697	24,646	10,032	2,680,640
Total	104	777,190	2,809,593	3.62	3,036,393	508,461	440,133	31,111	2,821,689	334,070	5,610,518	47,075	10,496	3,740,806

Tennessee.—The production reported for Tennessee in 1910 was from the quarries of the Southern Slate Co., at Chilhowee, Blount County. Other slate properties at Tellico Plains, Monroe County, Kingsport, Sullivan County, and near Washington College, Washington County, are being prospected and developed, but no material has as yet been put on the market.

Vermont.—Vermont ranks next to Pennsylvania in the production of slate, and in 1910 produced 30.38 per cent of the total value of the United States output, as compared with 59.98 per cent produced by Pennsylvania. In 1909 these figures for Vermont and Pennsylvania were 33.84 per cent and 53.15 per cent, respectively—a loss for Vermont and an increase for Pennsylvania in 1910. There was a small increase in the total value of the Vermont slate product from $1,841,589 in 1909 to $1,894,659 in 1910, a gain of $53,070.

This gain was chiefly in the value of roofing slate, which increased in value from $1,533,936 in 1909 to $1,585,324 in 1910, a gain of $51,388. The quantity, however, decreased from 397,441 squares in 1909 to 395,640 squares in 1910, a loss of 1,801 squares. The average price per square increased from $3.86 in 1909 to $4.01 in 1910. The output of mill stock decreased in quantity from 1,345,503 square feet in 1909 to 1,316,732 square feet in 1910, a decrease of 28,771 square feet, with a gain of $1,464 in value from $307,347 in 1909 to $308,811 in 1910. The average price of mill stock in 1910 was 23.5 cents, as compared with 22.8 cents in 1909. Of the total value of mill stock (exclusive of blackboards and school slates) produced in the United States, Vermont produced 30.91 per cent of the total value in 1910, compared with 54.01 per cent from Pennsylvania.

The Vermont slate is practically all from Rutland County, and the quarries are in the same slate belt as the New York slate quarries. In 1910, however, there was a small production from the Northfield, Washington County, slate quarries, of very dark-gray or "black" slate. A deposit was also reported to be under development near Halifax, Windham County. The Rutland County slate varies in color and is known in the trade as "sea green," "grayish green," "unfading green," "greenish gray," "purple," "purplish brown," "variegated," and other variations of green, gray, and purple.

Virginia.—The slate quarried in Virginia is used entirely for roofing, the production in 1910 being 31,787 squares, valued at $148,721, or $4.68 per square. This was a decrease of 9,093 squares in quantity and of $32,054 in value, as compared with 1909, when the production was 40,880 squares, valued at $180,775, or $4.42 per square. This decrease was due to a strike of skilled laborers from June 1 to December 1, 1910, most of the quarries being closed during that time.

The Virginia slate is produced at Esmont, Albemarle County, Snowden, Amherst County, and Arvonia and Penlan, Buckingham County. A deposit near Palmyra, in Fluvanna County, is now under development, but without commercial output.

STONE.

By Ernest F. Burchard.

INTRODUCTION.

The value of the stone produced in the United States in 1910 was $76,520,584, as compared with $71,345,199 in 1909, an increase of more than 7 per cent. The year 1910 surpassed all previous years in the value of its stone output. The values of granite, trap rock, marble, bluestone, and limestone each showed an increase in 1910 over those of 1909; but the value of sandstone decreased slightly in 1910 as compared with that in 1909.

In 1910 the total value of the stone output for Pennsylvania exceeded that for any other State. Pennsylvania has held first rank in recent years except 1908, when Vermont reported the largest production.

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 rough and 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 statistical inquiry 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.

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 1900 to 1910, inclusive:

Value of the different kinds of stone produced in the United States, 1900–1910.

Year.	Granite.	Trap rock.	Sandstone.	Bluestone.	Marble.	Limestone.	Total.
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
1910	20,541,967	6,452,141	6,394,832	1,535,187	6,992,779	34,603,678	76,520,584

From this table it will be seen that the stone output of the United States increased $5,175,385 in value, from $71,345,499 in 1909 to $76,520,584 in 1910.

Granite.—The value of granite represented nearly 27 per cent of the total value of stone in 1910. The increase in value was from $19,581,597 in 1909 to $20,541,967 in 1910, or $960,370. Granite for paving blocks and curbing increased in value, but there was a decrease in the value of building granite. The value of granite for monumental work increased and that of flagging decreased.

Trap rock.—Trap rock increased in value from $5,133,842 in 1909 to $6,452,141 in 1910, or $1,318,299. The trap-rock output is chiefly crushed stone.

Sandstone.—Sandstone, including quartzite, decreased in value from $6,564,052 in 1909 to $6,394,832 in 1910, or $169,220.

Bluestone.—The value of bluestone increased from $1,446,402 in 1909 to $1,535,187 in 1910, a gain of $88,785.

Marble.—The value of marble represented more than 9 per cent of the total stone value in 1910, and increased from $6,548,905 in 1909 to $6,992,779 in 1910, or $443,874.

Limestone.—The value of limestone represented more than 45 per cent of the total value of stone produced in 1910, and increased from $32,070,401 in 1909 to $34,603,678 in 1910, an increase of $2,533,277.

The following table shows the value of the various kinds of stone produced in 1909 and 1910, by States and Territories:

Value of various kinds of stone produced in 1909 and 1910, by States and Territories.

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	fg 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.

Value of various kinds of stone produced in 1909 and 1910, by States and Territories—Continued.

1910.

State or Territory.	Granite.	Trap rock.	Sandstone.	Marble.	Limestone.	Total value.
Alabama			$109,063	a $255,664	$714,516	$1,079,243
Alaska				(a)		(a)
Arizona	(b)		131,716	(a)	(c)	131,716
Arkansas	$226,690		71,641		84,280	382,611
California	1,520,299	$1,955,335	113,488	a 112,339	590,990	4,292,451
Colorado	93,679		189,603	a 488,173	415,523	1,186,978
Connecticut	410,535	500,229	(d)		c 9,062	919,826
Delaware	357,708					357,708
Florida					c 84,457	84,457
Georgia	1,049,186			953,917	24,236	2,027,339
Hawaii	139,724					139,724
Idaho	(b)		34,070		19,423	53,493
Illinois			5,710		3,847,715	3,853,425
Indiana			4,141		4,472,241	4,476,382
Iowa			14,456		543,600	558,056
Kansas			25,691		768,739	794,430
Kentucky			90,729	(a)	978,809	1,069,538
Louisiana					(c)	(c)
Maine	2,315,730				(c)	2,315,730
Maryland	982,746		18,226	(a)	154,370	1,155,342
Massachusetts	1,567,754	797,048	d 424,485	a 224,088	(c)	3,013,375
Michigan	(b)		31,233		842,126	873,359
Minnesota	858,734		483,578		654,833	1,997,145
Missouri	120,663		39,398		2,360,604	2,520,665
Montana	(b)		59,019		169,836	228,855
Nebraska					338,731	338,731
Nevada			(d)			(d)
New Hampshire	1,239,656					1,239,656
New Jersey	80,105	1,257,712	112,650		224,707	1,675,174
New Mexico	(b)		1,402	(a)	c 227,657	229,059
New York	330,716	970,994	d 1,810,770	484,732	2,813,476	6,410,688
North Carolina	839,742		(d)	(a)	(c)	839,742
Ohio			1,402,131		4,357,432	5,759,563
Oklahoma	102,566		19,801		509,344	631,711
Oregon	1,080,009		d 30,375		3,594	1,113,978
Pennsylvania	478,919	970,823	d 1,595,070	a 182,514	5,394,611	8,621,937
Rhode Island	521,490				(c)	521,490
South Carolina	369,448				(c)	369,448
South Dakota			156,576		17,150	173,726
Tennessee			(d)	728,502	c 747,162	1,475,664
Texas	66,909		40,471		447,239	554,619
Utah	6,783		43,589	(a)	389,603	439,975
Vermont	2,694,474			3,562,850	25,250	6,282,574
Virginia	503,106		25,080		471,903	1,000,089
Washington	642,992		438,581	(a)	36,186	1,117,759
West Virginia			d 212,308	(a)	841,064	1,053,372
Wisconsin	1,475,342		189,654		979,522	2,644,518
Wyoming			5,314		43,687	49,001
Other States	b 466,262					b 466,262
Total	e 20,541,967	6,452,141	f 7,930,019	6,992,779	34,603,678	76,520,584

a To prevent disclosure of individual production, Alabama includes Kentucky, North Carolina, and West Virginia; California includes Alaska and Washington; Colorado includes Arizona, New Mexico, and Utah; and Pennsylvania includes Maryland.

b "Other States" includes Arizona, Idaho, Montana, Nevada, and New Mexico; Minnesota includes a small value of trap rock for Michigan and Minnesota.

c Florida includes Louisiana; Connecticut includes Maine, Massachusetts, and Rhode Island; New Mexico includes Arizona; Tennessee includes North Carolina and South Carolina.

d Massachusetts includes Connecticut; Oregon includes Nevada; West Virginia includes North Carolina and Tennessee; New York and Pennsylvania include bluestone.

e Includes small values for trap, basalt, and other igneous rocks.

f Includes bluestone in New York and Pennsylvania, and quartzite in California, Minnesota, South Dakota, and Wisconsin.

The following table shows the rank of States and Territories in 1909 and 1910, according to value of production of stone, and the percentage of the total produced by each State or Territory. The large increase in Oregon was due to a large output of basalt quarried for Columbia River improvement work.

Rank of States and Territories in 1909 and 1910, according to value of production of stone, and percentage of total produced by each State or Territory.

1909				1910			
Rank of State.	State or Territory.	Total value.	Percentage of total.	Rank of State.	State or Territory.	Total value.	Percentage of total.
1	Pennsylvania	$8,125,723	11.39	1	Pennsylvania	[b]$8,621,937	11.27
2	Vermont	6,324,306	8.86	2	New York	6,410,688	8.38
3	New York	5,660,598	7.93	3	Vermont	6,282,574	8.21
4	Ohio	5,659,052	7.93	4	Ohio	5,759,563	7.53
5	Illinois	4,261,818	5.97	5	Indiana	4,470,382	5.85
6	Indiana	3,753,358	5.26	6	California	[b]4,292,451	5.60
7	Massachusetts	[a]3,539,794	4.96	7	Illinois	3,853,425	5.04
8	California	3,444,900	4.83	8	Massachusetts	[b]3,013,375	3.94
9	Wisconsin	2,694,308	3.78	9	Wisconsin	2,644,518	3.46
10	Missouri	2,295,763	3.22	10	Missouri	2,520,665	3.29
11	Maine	[a]1,939,524	2.72	11	Maine	[b]2,315,730	3.03
12	Minnesota	[a]1,658,490	2.32	12	Georgia	2,027,339	2.65
13	Georgia	1,644,584	2.31	13	Minnesota	[b]1,997,145	2.61
14	New Jersey	1,613,861	2.26	14	New Jersey	1,675,174	2.19
15	New Hampshire	1,215,461	1.70	15	Tennessee	[b]1,455,889	1.90
16	Tennessee	1,163,915	1.63	16	New Hampshire	1,239,656	1.62
17	Washington	1,116,617	1.57	17	Colorado	[b]1,186,328	1.55
18	Colorado	[a]1,114,878	1.56	18	Maryland	[b]1,155,342	1.51
19	West Virginia	[a]1,065,205	1.49	19	Washington	[b]1,117,759	1.46
20	Maryland	[a]1,023,255	1.43	20	Oregon	[b]1,114,378	1.46
21	Kentucky	[a]994,709	1.39	21	Kentucky	[b]1,069,538	1.40
22	Connecticut	[a]983,192	1.38	22	Alabama	[b]1,058,368	1.38
23	Rhode Island	[a]933,053	1.31	23	West Virginia	1,054,192	1.38
24	Alabama	[a]924,140	1.30	24	Virginia	1,000,089	1.31
25	Kansas	911,895	1.28	25	Connecticut	[b]919,826	1.20
26	Virginia	859,480	1.21	26	North Carolina	879,572	1.15
27	North Carolina	806,659	1.13	27	Michigan	[b]873,359	1.14
28	Michigan	[a]786,673	1.10	28	Kansas	794,430	1.04
29	Texas	[a]579,589	.81	29	Oklahoma	631,711	.83
30	Oklahoma	577,494	.81	30	Iowa	558,056	.73
31	Iowa	527,720	.74	31	Texas	554,619	.72
32	Delaware	456,328	.64	32	Rhode Island	[b]521,490	.68
33	Arkansas	330,603	.46	33	Montana	[b]456,539	.60
34	Arizona	[a]316,938	.44	34	New Mexico	443,650	.58
35	New Mexico	300,313	.42	35	Utah	439,975	.57
36	Nebraska	293,830	.41	36	Arkansas	382,611	.50
37	Oregon	[a]284,135	.40	37	South Carolina	[b]369,448	.48
38	Montana	[a]276,560	.39	38	Delaware	357,708	.47
39	Utah	[a]248,460	.35	39	Nebraska	338,731	.44
40	South Carolina	218,045	.31	40	South Dakota	173,726	.23
41	South Dakota	[a]148,411	.21	41	Arizona	[b]155,953	.20
42	Hawaii	[a]68,955	.10	42	Hawaii	139,724	.18
43	Idaho	68,315	.10	43	Florida	[b]84,457	.11
44	Alaska	[a]46,900	.07	44	Idaho	[b]53,493	.13 (44 and 45)
45	Wyoming	37,476	.05	45	Wyoming	49,001	
46	Louisiana	49,856 (46 and 47)	.07 (46 and 47)	46	Alaska	(b)	
47	Florida			47	Louisiana	(b)	
48	North Dakota	(a)		48	Nevada	(b)	
49	Nevada	(a)					
	Total	71,345,199	100.00		Total	76,520,584	100.00

[a] 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.

[b] To prevent disclosure of individual figures, Alabama includes a small value for Kentucky; California for Alaska and Washington; Colorado for Arizona and Utah; Connecticut for Massachusetts, Maine, and Rhode Island; Florida for Louisiana; Massachusetts for Connecticut; Minnesota for Michigan; Montana for Idaho; Oregon for Nevada; Pennsylvania for Maryland; and Tennessee for South Carolina.

The following table shows the value of the stone used for various purposes in 1909 and 1910. 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 1909 and 1910.

1909.

Kinds.	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

1910.

Kinds.	Building (rough and dressed).	Monumental (rough and dressed).	Flagstone.	Curbstone.	Paving stone.	Crushed stone.
Granite	$5,609,313	$4,716,561	$44,338	$1,019,529	$2,823,772	$4,208,112
Trap rock	87,832				225,645	5,984,908
Sandstone	2,778,892		649,079	881,902	899,595	1,406,153
Limestone	5,272,024		36,807	165,781	464,837	15,665,362
Marble	2,357,795	2,170,981				
Total	16,105,856	6,887,542	730,224	2,067,212	4,413,849	27,264,535

This table shows from a point of view slightly different from that of the preceding tables the changes in the stone industry from 1909 to 1910. The value of stone sold for building purposes showed a decrease of $1,488,599, which was mainly confined to the output of granite and sandstone, although the use of marble for building purposes decreased slightly in 1910. Monumental stone increased in value in 1910, granite and marble together showing an increase of $783,352. Flagstone showed a decrease in value of $313,632, granite, sandstone, limestone, and flagstone each showing a loss as compared with 1909. The total value of curbstone showed a loss of $115,263 in 1910 as compared with the value for 1909. The value of granite, sandstone, and limestone used for curbing decreased. The value of stone used for paving increased $655,189. The value of granite, sandstone, and limestone for paving showed an increase, but the value of trap rock, one of the materials most used for paving blocks on the Pacific coast, decreased slightly. Crushed stone increased $3,185,755 in value in 1910 above the value in 1909. 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 1901 to 1910. 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, 1901–1910.

Years.	Building stone (rough and dressed).	Crushed stone.	Years.	Building stone (rough and dressed).	Crushed stone.
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
1905	20,240,809	16,419,614	1910	16,105,856	27,264,535

The following table shows the quantity and value of crushed stone produced in the United States in 1909 and 1910, by States and Territories and by uses:

Production of crushed stone in 1909 and 1910, by States and Territories and by uses, in short tons.

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

Production of crushed stone in 1909 and 1910, by States and Territories and by uses, in short tons—Continued.

1910.

State or Territory.	Road making.		Railroad ballast.		Concrete.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Alabama	87,802	$64,872	12,465	$5,842	67,887	$72,199	168,154	$142,913
Arizona	9,754	7,225	5,250	5,000	27,363	25,954	42,367	38,179
Arkansas	242,843	185,819	66,178	42,582	38,200	31,160	347,221	259,561
California	1,957,020	1,424,585	595,025	328,855	1,433,544	952,660	3,985,589	2,706,100
Colorado	16,600	26,600	19,728	9,140	29,767	26,474	66,095	62,214
Connecticut	430,023	244,067	242,381	109,616	317,565	167,428	989,969	521,111
Delaware	29,826	23,561	37,794	26,456	60,730	51,637	128,350	101,654
Florida	24,661	30,250			2,500	3,000	27,161	33,250
Georgia	12,592	10,881	97,455	82,559	310,846	246,824	420,893	340,264
Hawaii	24,949	33,502	500	825	66,808	75,764	92,257	110,091
Idaho	2,700	1,000			1,875	1,500	4,575	2,500
Illinois	1,075,476	954,409	1,300,282	520,132	2,054,915	953,502	4,430,673	2,428,043
Indiana	1,102,834	551,021	297,889	125,498	259,565	133,186	1,660,288	809,705
Iowa	71,664	57,168	67,852	35,434	335,550	259,262	475,066	351,864
Kansas	98,789	72,965	550,867	271,023	219,371	167,096	869,027	511,084
Kentucky	448,344	288,611	724,132	317,221	269,847	115,602	1,442,323	721,434
Louisiana			1,750	1,400	20,625	16,500	22,375	17,900
Maine	8,232	8,831	13,242	11,047	3,262	3,792	24,736	23,670
Maryland	523,381	427,430	157,426	77,352	201,972	179,067	882,779	683,849
Massachusetts	594,836	457,367	171,355	81,862	611,180	476,677	1,377,371	1,015,906
Michigan	198,966	110,184	141,093	42,358	443,816	178,318	783,875	330,860
Minnesota	132,805	118,944	26,847	24,091	352,508	295,746	512,160	438,781
Missouri	658,196	530,669	349,403	204,988	587,646	499,447	1,595,245	1,235,104
Montana	450	150					450	150
Nebraska	10,000	10,000			281,006	229,164	291,006	239,164
Nevada	1,250	500					1,250	500
New Hampshire	1,203	861	703	611	25,623	17,729	27,529	19,201
New Jersey	907,920	755,918	466,288	269,760	390,125	275,737	1,764,333	1,301,415
New Mexico			930,797	432,106	19,640	9,367	950,437	441,473
New York	3,069,158	1,804,838	1,119,950	559,080	1,416,069	966,389	5,605,177	3,330,307
North Carolina	159,888	138,216	174,214	98,516	60,824	51,547	394,926	288,279
Ohio	2,894,875	1,314,192	1,955,248	789,130	797,315	377,523	5,647,438	2,480,845
Oklahoma	30,916	20,983	300,066	162,932	34,041	157,892	665,023	341,807
Oregon	320,863	304,646			81,062	67,715	401,925	372,361
Pennsylvaina	1,417,111	816,783	1,873,673	1,024,600	1,328,448	791,318	4,619,232	2,632,701
Rhode Island	28,723	32,136	3,468	3,919	17,974	21,742	50,165	57,797
South Carolina	53,795	49,977	24,741	23,009	79,134	78,375	157,670	151,361
South Dakota	6,390	9,441			17,905	14,138	24,295	23,579
Tennessee	348,142	279,580	298,485	123,530	176,076	102,788	822,703	505,898
Texas	125,944	92,514	36,437	24,244	226,670	190,104	389,051	306,862
Utah					3,200	5,100	3,200	5,100
Virginia	73,863	62,247	507,941	237,940	249,413	192,493	831,217	492,680
Vermont	17,247	13,218	567	234	7,902	8,069	25,716	21,521
Washington	185,212	193,993	560	350	16,095	12,864	201,867	207,207
West Virginia	5,844	3,549	571 251	274,569	74,930	51,677	652,025	329,795
Wisconsin	674,083	377,543	112,259	48,380	623,022	380,208	1,409,364	806,131
Wyoming					24,124	22,364	24,124	22,364
Total	18,085,170	11,911,246	13,255,562	6,396,191	13,967,940	8,957,098	45,308,672	27,264,535

According to this table there were eight States that produced crushed stone valued at more than $1,000,000, as follows: New York, California, Pennsylvania, Ohio, Illinois, New Jersey, Missouri, and Massachusetts.

The following table shows the quantity and value of crushed stone produced in the United States in 1909 and 1910 by uses and kinds of stone:

Quantity and value of crushed stone produced in the United States in 1909 and 1910, by kinds and uses, in short tons.

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	....	$0.67	....	$0.48	....	$0.64	....	$0.61	....

1910.

Kind.	Road making.		Railroad ballast.		Concrete.		Total.		Average price per ton.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
Granite	2,280,574	$1,957,206	1,680,524	$876,192	1,617,062	$1,374,714	5,578,160	$4,208,112	$0.75
Trap rock	4,494,714	3,104,353	1,756,003	983,370	2,945,748	1,897,185	9,196,465	5,984,908	.65
Limestone	10,947,794	6,595,717	9,340,573	4,288,431	8,375,613	4,781,214	28,663,980	15,665,362	.55
Sandstone	362,088	253,970	478,462	248,198	1,029,517	903,985	1,870,067	1,406,153	.75
Total	18,085,170	11,911,246	13,255,562	6,396,191	13,967,940	8,957,098	45,308,672	27,264,535	....
Average price	....	$0.66	....	$0.48	....	$0.64	....	$0.60	....

As shown by this table the quantity and value of the crushed stone output in 1910 was 45,308,672 short tons, valued at $27,264,535, an increase of $6,093,097 tons in quantity, and of $3,185,755 in value over the output in 1909. The average price per ton was 60 cents, as compared with 61 cents in 1909.

Crushed granite increased 1,669,694 tons in quantity and $1,144,102 in value. The average price per ton decreased from 78 cents in 1909 to 75 cents in 1910.

Crushed trap rock increased 1,899,906 short tons in quantity and $1,235,822 in value. The average price per ton, 65 cents, was the same as in 1909.

Crushed limestone increased 2,371,215 short tons in quantity and $612,609 in value. The average price per ton decreased from 57 cents in 1909 to 55 cents in 1910.

Crushed sandstone increased 152,282 short tons in quantity and $193,222 in value. The average price per ton was 71 cents in 1909 and 75 cents in 1910.

Crushed stone used for road making decreased 57,509 short tons in quantity and $304,166 in value. The average price per ton decreased from 67 cents in 1909 to 66 cents in 1910.

Crushed stone for railroad ballast increased 3,184,277 short tons in quantity and $1,543,973 in value. The average price per ton, 48 cents, was the same as in 1909.

Crushed stone for concrete increased 2,966,329 short tons in quantity and $1,945,948 in value. The average price per ton, 64 cents, was the same as 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 1909 and 1910:

Exports of stone from the United States in 1909 and 1910.

Kind.	1909	1910
Marble and stone, unmanufactured	$335,020	$503,251
All others	835,799	1,035,088
Total	1,170,819	[a] 1,538,339

[a] Includes exports of slate.

Imports of stone into the United States in 1909 and 1910.

Kind.	1909	1910
Marble:		
In block, rough, etc	$1,013,458	$934,328
Sawed or dressed	14,832	958
Slabs or paving tiles	58,562	75,040
All other manufactures	204,557	220,489
Mosaic cubes	33,582	42,829
Total	1,324,991	1,273,644
Onyx:		
In block, rough, etc	81,787	58,736
All other manufactures	2,720	1,537
Total	84,507	60,273
Granite:		
Dressed	$182,066	$172,121
Rough	8,352	4,791
Total	190,418	176,912
Stone (other):		
Dressed	45,662	46,018
Rough	17,447	12,296
Total	63,109	58,314
Grand total	1,663,025	1,569,143

These tables show an increase of $367,520 in the value of the exports of stone during 1910 and a decrease of $93,882 in the value of the imports. Both imports and exports increased in value from 1908 to 1909.

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, represents, however, an industry sufficient by itself to make it advisable to tabulate this stone separately, and therefore its value is not included in the grand total of granite. The value of the granite produced in the United States in 1910 was $20,541,967, an increase of $960,370, or 4.9 per cent, as compared with $19,581,597, the value in 1909.

Rough granite for monumental work, granite sold dressed for monumental work, granite for paving blocks, crushed granite for roads, railroad ballast, and concrete, and granite for miscellaneous purposes not specified in the returns, increased in value; rough granite for building purposes, granite sold dressed for building purposes, and granite sold for rubble, riprap, curbing, and flagging showed a decrease. Fourteen States produced granite valued at more than $500,000 in 1910, in the following order: Vermont, Maine, Massachusetts, California, Wisconsin, New Hampshire, Oregon, Georgia, Maryland, Minnesota, North Carolina, Washington, Rhode Island, and Virginia. Of these States the first eight produced granite valued at more than $1,000,000. All of them showed an increase except Vermont, Massachusetts, Wisconsin, Washington, Rhode Island, and Virginia.

The following table shows the value of the production of granite, including a small output of other igneous rocks, in the United States from 1906 to 1910 inclusive:

Value of granite, etc., produced in the United States, by States and Territories, 1906–1910.

State or Territory.	1906	1907	1908	1909	1910
Arizona	$32,042	$13,700	$8,544	(a)	(a)
Arkansas	118,903	168,996	152,567	$150,179	$226,690
California	740,784	1,306,324	1,684,504	1,310,520	1,520,299
Colorado	65,402	67,134	121,282	74,326	93,679
Connecticut	974,024	591,153	592,904	610,514	410,535
Delaware	146,346	158,192	195,761	456,328	357,708
Georgia	792,315	858,603	970,832	843,542	1,049,186
Hawaii	23,346	19,599	81,219	68,955	139,724
Idaho	400	25,942	(a)	(a)	(a)
Maine	2,560,021	2,146,420	2,027,508	1,939,524	2,315,730
Maryland	883,881	1,183,753	762,442	771,224	982,746
Massachusetts	3,327,416	2,328,777	2,027,463	2,164,619	1,567,754
Michigan	....	....	....		
Minnesota	626,069	546,603	629,427	} [b] 660,823	[b] 858,734
Missouri	150,009	136,405	157,968	155,717	120,663
Montana	114,005	102,050	(a)	(a)	(a)
Nevada	....	....	....	....	(a)
New Hampshire	818,131	647,721	867,028	1,215,461	1,239,656
New Jersey	101,224	75,757	125,804	60,175	80,105
New Mexico	....	167,294	....	(a)	(a)
New York	304,048	289,722	367,066	443,910	330,716
North Carolina	778,847	889,976	764,272	743,876	839,742
Oklahoma	18,847	24,550	23,239	67,584	102,566
Oregon	58,961	117,625	271,869	284,135	1,080,009
Pennsylvania	349,453	366,679	324,241	507,814	478,919
Rhode Island	622,812	674,148	556,474	933,053	521,490
South Carolina	247,998	129,377	297,874	218,045	369,448
South Dakota	....	690	(a)	....	....
Texas	168,061	122,158	190,055	173,271	66,909
Utah	4,948	5,240	5,229	7,525	6,783
Vermont	2,934,825	2,693,889	2,451,933	2,811,744	2,694,474
Virginia	340,900	398,426	321,530	488,250	503.106
Washington	459,975	562,352	870,944	742,878	642,992
Wisconsin	798,213	1,228,863	1,529,781	1,442,305	1,475,342
Wyoming	600	90	(a)	....	....
Other States	....	....	40,320	[c] 235,300	[d] 466,262
Total	18,562,806	18,064,708	18,420,080	19,581,597	20,541,967

[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.
[d] Includes Arizona, Idaho, Montana, Nevada, 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 1909 and 1910, by States and Territories and uses:

Value of granite and other igneous rocks in the United States in 1909 and 1910, by States and Territories and uses.

1909.

State or Territory.	Sold in the rough. Building.	Monumental.	Rubble.	Riprap.	Other.	Dressed for building.	Dressed for monumental work.	Made into paving blocks.
rizona								
rkansas	$1,000		$9,522	$68,000		$799	$120	
alifornia	30,536	$39,579	12,798	109,847	$2,875	432,551	97,978	$34,470
olorado	15,267	28,451	4,950	18	1,200	24,000		
onnecticut	25,097	35,867	5,342	112,830	1,382	274,501	66,538	8,698
elaware	9,769		1,557	280,488		2,043		9,084
eorgia	39,685	28,174	33,216	59,245		120,270	2,693	93,300
awaii	3,100							
daho								
aine	237,597	31,375	14,685	14,090	26,271	1,152,677	39,704	262,895
aryland	120,561	8,471	70,479	6,695	4,450	114,002	2,675	93,742
assachusetts	212,075	508,805	51,658	2,462	17,752	542,441	298,235	308,203
ichigan								
innesota	43,659	76,636	48,210	1,093		144,997	167,088	66,605
issouri	4,093	46,750		3,878		5,930	2,300	46,163
ontana								
ew Hampshire	143,757	70,018	23,387	4,367	200	521,299	192,762	170,434
ew Jersey	7,366	1,000	150	200	942	1,133	50	2,250
ew Mexico								
ew York	35,399	1,864	17,639	5,421	2,971	17,193	23,903	250,070
orth Carolina	56,859	11,682	5,803	34		142,778	38,192	214,508
klahoma	1,471	16,541	13,050	8,000		15,408	5,691	
regon	6,996	5,460				2,321	16,129	37,348
ennsylvania	306,466	10,400	4,751		1,950	53,529		15,840
hode Island	45,501	176,565	1,510		73	218,089	314,237	52,004
outh Carolina	67,877	5,215	19,680	53,037	1,755	1,000		4,284
exas	29,530	36,082		22,141	2,875	36,612	11,400	
tah	996	4,396					2,133	
ermont	128,233	1,154,826	1,037	4,100	100	1,035,075	479,415	5,824
irginia	24,965	1,966	33,321	1,386		17,750	9,449	18,053
ashington	11,478	6,308	423,230	18,408		17,185	19,902	66,544
isconsin	300	26,984	420			5,154	212,043	982,798
ther States [a]	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	2,743,117

State or Territory.	Curbing.	Flagging.	Crushed stone. Road-making.	Railroad ballast.	Concrete.	Other.	Total.
rizona							(b)
rkansas	$300		$68,338	$1,470	$630		$150,179
alifornia	163,012	$375	262,077	57,064	65,020	$2,338	1,310,520
olorado						440	74,326
onnecticut	45,573	250	7,834		23,752	2,850	610,514
elaware	3,960		20,105	98,485	30,337	500	456,328
eorgia	318,957	240	16,405	46,864	83,497	996	843,542
awaii			40,855		25,000		68,955
daho							(b)
aine	74,739	13,770	10,786	330	7,849	52,756	1,939,524
aryland	3,474	2,427	138,465	38,576	158,468	8,739	771,224
assachusetts	113,705	3,666	56,805	8,533	36,344	3,935	2,164.619
ichigan							(c)
innesota	8,154	150	40,221	26,220	36,540	1,250	[d] 660,823
issouri			15,345		31,258		155,717
ontana							(b)
ew Hampshire	53,038	635	21,429		9,360	4,775	1,215,461
ew Jersey				44,960	2,124		60,175
ew Mexico							(b)
ew York	1,352		52,263	2,600	33,235		443,910
orth Carolina	98,153	1,233	44,617	28,151	101,866		743,876
klahoma	2,000				3,500	1,923	67,584
regon		3,004	206,372	1,025	5,480		284,135
ennsylvania	8,401	3,490	41,047	5,625	39,004	17,311	507,814
hode Island	5,955		99,358	2,617	17,125	19	933,053
outh Carolina	3,554	125	10,672	15,827	32,834	2,185	218,045
exas	1,100		32,584		947		173,271
tah							7,525
ermont	1,319		765	1,000		50	2,811,744
irginia	29,100	990	74,054	125,704	147,112	4,400	488,250
ashington	76,574		88,868			14,381	742,878
isconsin	3,048	16,875	125,838		23,385	45,460	1,442,305
ther States [a]	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] "Other States" includes Arizona, Idaho, Montana, and New Mexico.
[b] Included in "Other States."
[c] A small value for trap rock included in Minnesota.
[d] Includes a value of trap rock for Michigan and Minnesota.

Value of granite and other igneous rocks in the United States in 1909 and 1910, by States and Territories and uses—Continued.

1910.

State or Territory.	Sold in the rough.					Dressed for building.	Dressed for monumental.	Made into paving blocks.
	Building.	Monumental.	Rubble.	Riprap.	Other.			
Arizona								
Arkansas		$80	$1,612	$11,600	$75	$8,000		
California	$67,132	42,380	62,649	48,113	103,327	278,091	$114,678	$28,925
Colorado	6,630	22,435	2,310				25,584	
Connecticut	21,643	19,098	6,022	45,636	9,170	160,933	40,164	35,761
Delaware	5,461			238,435		1,227		7,818
Georgia	60,696	45,363	29,970	24,110	1,025	65,188	2,001	195,207
Hawaii	2,800			26,833				
Idaho								
Maine	299,070	90,194	36,846	36,681	7,730	954,513	200,105	548,374
Maryland	124,275	29,173	65,610	1,414	7,659	94,389	19,700	60,612
Massachusetts	202,375	461,814	16,703	20,631	78,761	349,431	32,600	201,425
Michigan								
Minnesota	22,971	127,907	3,983	2,297	7,150	182,341	313,187	83,658
Missouri	1,958	34,719		3,367		5,292	5,800	28,889
Montana								
Nevada								
New Hampshire	101,672	64,321	6,046	4,881	3,064	576,271	153,373	233,836
New Jersey	6,772	750	480	850	1,715	1,338		400
New Mexico								
New York	34,617	38,254	2,026	17,297	950	6,291	25,344	100,127
North Carolina	57,265	9,141	4,297	11,520	800	126,043	68,904	164,265
Oklahoma	3,770	7,943	4,530	1,600	400	66,792	12,386	720
Oregon	12,777	15,368		5,820	646,542	6,391	1,500	20,000
Pennsylvania	262,913	4,059	9,262	21,743	35,854	51,381	23,842	20,452
Rhode Island	16,439	166,306	152	26	610	43,140	185,079	40,411
South Carolina	20,499	77,864	1,755	5,035	46,200	15,950	46,724	
Texas	11,219	30,090		3,600				
Utah	420	5,000				1,088	275	
Vermont	76,807	1,197,187	98	272	2,020	887,430	495,449	25,915
Virginia	31,841	3,771	38,792	6,989	2,375	14,750	6,300	28,596
Washington	5,976	2,945	62,092	4,598	121,557	28,910	49,246	58,986
Wisconsin	1,226	109,000	1,836	404	7,123	1,000	294,533	939,020
Other States[a]	3,909	700				220,000	3,925	375
Total	1,463,133	2,605,862	357,071	543,752	1,084,107	4,146,180	2,110,699	2,823,772

State or Territory.	Curbing.	Flagging.	Crushed Stone.			Other.	Total.
			Road making.	Railroad ballast.	Concrete.		
Arizona							(b)
Arkansas	$200		$177,457	$13,333	$14,333		$226,690
California	98,787	$500	393,611	139,406	120,802	$21,898	1,520,299
Colorado	1,320		26,600		8,800		93,679
Connecticut	33,809	2,189	14,880		19,717	1,513	410,535
Delaware	3,113		23,561	26,456	51,637		357,708
Georgia	290,555		10,555	79,153	245,315	48	1,049,186
Hawaii			33,502	825	75,764		139,724
Idaho							(b)
Maine	94,091	20,557	8,831	11,047	3,792	3,899	2,315,730
Maryland	2,210	3,065	330,977	70,690	136,380	46,592	982,746
Massachusetts	114,389	7,017	35,643	133	41,137	5,695	1,567,754
Michigan							(c)
Minnesota	14,404	105	53,181	16,530	24,777	6,243	d 858,734
Missouri			21,110		19,528		120,663
Montana							(b)
Nevada							(b)
New Hampshire	60,369	2,282	861	611	17,729	14,340	1,239,656
New Jersey			8,775	45,943	12,206	876	80,105
New Mexico							(b)
New York	3,524	1,500	18,030	2,515	78,862	1,379	330,716
North Carolina	125,478	300	119,466	98,516	51,547	2,200	839,742
Oklahoma		3,000	75		1,000	350	102,566
Oregon	250		303,846		67,515		1,080,009
Pennsylvania	6,068		7,168	758	35,138	281	478,919
Rhode Island	11,530		32,136	3,919	21,742		521,490
South Carolina	3,860	200	49,977	23,009	78,375		369,448
Texas					22,000		66,909
Utah							6,783
Vermont	2,365		2,378	234	4,319		2,694,474
Virginia	57,511	1,565	40,691	53,761	211,444	4,720	503,106
Washington	84,141		192,916	350	12,864	18,411	642,992
Wisconsin	9,055	2,058	50,979		52,141	6,967	1,475,342
Other States[a]	2,500			230,953	3,900		466,262
Total	1,019,529	44,338	1,957,206	818,142	1,432,764	135,412	20,541,967

[a] Includes Arizona, Idaho, Montana, Nevada, and New Mexico.
[b] Included in "Other States."
[c] Included in Minnesota.
[d] Includes a small value for traprock for Michigan and Minnesota.

The following table shows the quantity and value of granite paving blocks produced in the United States in 1909 and 1910, by States:

Number and value of granite paving blocks produced in 1909 and 1910, by States and Territories.

State or Territory.	Paving blocks.			
	1909		1910	
	Number.	Value.	Number.	Value.
Arizona			8,000	$375
California	817,500	$34,470	698,740	28,925
Connecticut	180,130	8,698	786,762	35,761
Delaware	187,095	9,084	126,715	7,818
Georgia	3,384,600	93,300	4,966,493	195,207
Maine	6,137,682	262,895	10,893,020	548,374
Maryland	1,107,149	93,742	1,035,830	60,612
Massachusetts	6,878,872	308,203	4,532,685	201,425
Minnesota	974,000	66,605	1,223,000	83,658
Missouri	1,150,914	46,163	747,581	28,889
New Hampshire	4,997,161	170,434	6,772,224	233,836
New Jersey	30,000	2,250	8,000	400
New York	3,571,997	250,070	1,251,950	100,127
North Carolina	5,062,500	214,508	3,499,497	164,265
Oklahoma			18,000	720
Oregon	936,260	37,348	500,000	20,000
Pennsylvania	374,171	15,840	466,296	20,452
Rhode Island	1,051,681	52,004	868,088	40,411
South Carolina	106,204	4,284		
Vermont	163,885	5,824	826,071	25,915
Virginia	853,300	18,053	680,602	28,596
Washington	1,109,072	66,544	1,083,065	58,986
Wisconsin	18,798,977	982,798	15,996,780	939,020
Total	57,873,150	2,743,117	57,089,399	2,823,772
Average price per thousand		$47.40		$49.46

This table shows a decrease in quantity of 783,751 blocks and an increase in value of $80,655 for the paving blocks cut in the United States in 1910. 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 $49.46 in 1910, an increase of $2.06 as compared with the price in 1909.

GRANITE PRODUCTION OF VERMONT.

A more detailed statement of the granite production of Vermont is of interest here, as Vermont at present produces more granite than any other State and as the granite industry is one of the principal sources of its wealth.

The following table shows the production of granite in Vermont in 1909 and 1910, by counties and uses:

Production of granite in Vermont in 1909 and 1910, by counties and uses.

1909.

County.	Number of firms reporting.	Building.				Monumental.				Paving.		Other uses.	Total value.
		Rough.		Dressed.		Rough.		Dressed.					
		Quantity (cubic feet).	Value.	Quantity (cubic feet).	Value.	Quantity (cubic feet).	Value.	Quantity (cubic feet).	Value.	Quantity (number of blocks).	Value.	Value.	
Washington and Orange	34	44,020	$17,457	381,730	$1,034,575	1,210,696	$1,094,616	173,242	$478,349	29,885	$897	$8,161	$2,297,910
Windsor	3	111,020	88,816										424,961
Caledonia and Essex	10	45,000	17,285	500	500	94,962	44,789						62,574
Windham	3	12,950	4,550			233	233	100	250	134,000	4,927	110	10,070
Orleans	3	750	125			37,943	15,188	400	816			100	16,229
Total	53	213,740	128,233	382,230	1,035,075	1,343,834	1,154,826	173,742	479,415	163,885	5,824	8,371	2,811,744
Average price per cubic foot			$0.60		$2.71		$0.86		$2.76				

1910.

County.	Number of firms reporting.	Building rough quantity (cubic feet).	Building rough value.	Building dressed quantity (cubic feet).	Building dressed value.	Monumental rough quantity (cubic feet).	Monumental rough value.	Monumental dressed quantity (cubic feet).	Monumental dressed value.	Paving quantity (number of blocks).	Paving value.	Other uses value.	Total value.
Washington and Orange	28	37,012	$22,446	246,969	$887,430	1,215,194	$1,120,843	134,459	$481,249	550,871	$14,050	$10,682	$2,121,456
Windsor	3	31,403	26,371										441,615
Caledonia, Essex, and Orleans	10	51,026	20,635			143,650	76,200	7,200	14,200			666	111,701
Windham	3	15,153	7,355			145	144			275,200	11,865	338	19,702
Total	44	134,594	76,807	246,969	887,430	1,358,989	1,197,187	141,659	495,449	826,071	25,915	11,686	2,694,474
Average price per cubic foot			$0.57		$3.60		$0.88		$3.50				

The decrease in the number of firms reporting active operations was due to the idleness of a number of small producers. The most noteworthy changes in value are the average values per cubic foot reported for dressed building granite and for dressed monumental granite. Both of these classes of granite brought low prices in 1909, but in 1910 the prices rose nearly to the levels of 1908.

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.

In the value of trap rock produced in Massachusetts is included the value of the slate quarried in the vicinity of Boston. The lack of fissility of this rock renders it unsuitable for any of the purposes for which slate is used, therefore it is crushed and used entirely for road making.

The total output of trap rock in 1910 was valued at $6,452,141, as compared with $5,133,842 in 1909, an increase of $1,318 299. Every State showed an increase. The principal increases were in the values of trap rock used for building, road making, railroad ballast, concrete work, and unclassified uses. The value of trap rock used in paving decreased slightly.

California, as in 1909, showed the largest value of trap rock products. New Jersey ranked second.

The following table shows the value of the trap rock output in the United States in 1909 and 1910, by States and uses:

Value of trap produced in the United States in 1909 and 1910, by States and uses.

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

1910.

State.	Building.	Paving.	Road making	Railroad ballast.	Concrete.	Other.	Total.
California	$1,630	$163,897	$710,688	$154,449	$820,958	$103,713	$1,955,335
Connecticut	8,321	332	228,981	109,616	147,711	5,268	500,229
Massachusetts	19,630	....	374,448	81,729	310,230	11,011	797,048
New Jersey	7,989	60,976	721,761	223,817	229,906	13,263	1,257,712
New York	20,377	....	780,060	8,660	144,806	17,091	970,994
Pennsylvania	29,885	440	288,415	405,099	243,574	3,410	970,823
Total	87,832	225,645	3,104,353	983,370	1,897,185	153,756	6,452,141

The following table shows the quantity and value of trap paving blocks produced in the United States in 1909 and 1910, by States:

Number and value of trap paving blocks produced in the United States, 1909–10, by States.

State.	Paving blocks.			
	1909		1910	
	Number.	Value.	Number.	Value.
California	3,060,078	$129,764	3,891,443	$163,897
Connecticut	80,590	2,720	9,475	332
New Jersey	2,105,720	92,379	2,114,117	60,976
Pennsylvania	50,000	1,800	11,000	440
Total	5,296,388	226,663	6,026,035	225,645
Average price per thousand		42.80		37.47

SANDSTONE.

PRODUCTION.

Total value.—The value of sandstone decreased from $8,010,454 in 1909 to $7,930,019 in 1910, or $80,435. The leading sandstone-producing States in 1910 were New York, Pennsylvania, and Ohio, in the order named. Of these, Pennsylvania and Ohio showed a decrease in production. Among the decreases which were notable in proportion to the total output for 1909 were those of Illinois and Oklahoma. In Iowa, Maryland, Minnesota, New York, Oregon, South Dakota, and Washington there were proportionately large increases in the value of the sandstone production.

In New York and Pennsylvania a part of the sandstone output is known to the trade as bluestone, the production of which is given also in a separate table.

The following table shows the value of the sandstone production in the United States from 1906 to 1910, inclusive, by States and Territories:

Value of sandstone (including quartzite) production in the United States, 1906–1910, by States and Territories.

State or Territory.	1906	1907	1908	1909	1910
Alabama	$40,467	$48,673	$34,099	$77,327	$109,063
Arizona	33,149	158,435	396,358	298,335	131,716
Arkansas	55,703	94,275	42,463	67,956	71,641
California	642,166	437,738	330,214	290,034	113,488
Colorado	286,544	299,443	181,051	197,105	189,603
Connecticut	(a)	(a)	55,949	(b)	(b)
Idaho	11,969	24,001	33,394	29,263	34,070
Illinois	19,125	14,996	12,218	26,891	5,710
Indiana	30,740	15,425	3,342	4,119	4,141
Iowa	5,600	3,542	2,337	2,443	14,456
Kansas	42,809	46,831	67,950	19,560	25,691
Kentucky	125,123	98,450	78,732	90,835	90,729
Maryland	9,533	13,859	6,262	10,584	18,226
Massachusetts	260,721	243,323	241,462	c 457,962	c 424,485
Michigan	65,395	53,003	39,103	36,084	31,233
Minnesota	285,433	300,204	197,184	299,358	483,578
Missouri	20,951	35,289	17,954	28,763	39,398
Montana	37,462	39,216	51,564	73,443	59,019
Nebraska	6,899	11,609	d 15,815	....	....
Nevada	....	....	(e)	(f)	(f)
New Jersey	215,142	177,667	154,422	189,098	112,650
New Mexico	42,574	12,450	g 10,410	4,963	1,402
New York	h c1,905,892	h c1,978,117	h 1,774,843	h 1,430,830	h 1,810,770
North Carolina	3,531	4,105	i 12,266	....	....
North Dakota	44	3,260	(j)	(k)	(l)
Ohio	1,426,645	1,591,148	1,244,752	1,639,006	1,402,131
Oklahoma	40,861	43,403	57,124	59,855	19,801
Oregon	25,950	3,904	(j)	g 4,811	g 30,375
Pennsylvania	h 2,724,874	h 2,064,913	h 1,368,784	h 1,637,794	h 1,595,070
South Dakota	145,966	143,585	128,554	m 118,029	156,576
Tennessee	14,136	16,523	(n)	(l)	(l)
Texas	111,533	108,047	154,948	61,600	40,471
Utah	137,529	24,298	25,097	71,235	43,589
Virginia	5,100	(l)	(n)	28,574	25,080
Washington	169,500	295,585	464,587	335,470	438,581
West Virginia	113,369	o 197,926	127,149	p 201,038	q 212,308
Wisconsin	181,986	236,183	219,130	204,959	189,654
Wyoming	24,715	32,252	44,574	13,130	5,314
Total	9,169,337	8,871,678	7,594,091	8,010,454	7,930,019

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 Included in West Virginia.
m Includes North Dakota.
n Included with North Carolina.
o Includes a small value for Virginia.
p Includes Tennessee.
q Includes Tennessee and North Carolina.

The following table shows the value of the sandstone, including quartzite, production of the United States in 1909 and 1910, by States and Territories and uses:

Value of sandstone (including quartzite) production in the United States in 1909 and 1910, by States and Territories and uses.

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	61,418			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 1909 and 1910, by States and Territories and uses—Continued.

1909.

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.

Value of sandstone (including quartzite) production in the United States in 1909 and 1910, by States and Territories and uses—Continued.

1910.

State or Territory.	Rough building.	Dressed building.	Ganister.	Paving.	Curbing.	Flagging.	Rubble.
Alabama	$100		$12,088				$20,802
Arizona	4,900	$52,188			$50		41,000
Arkansas	3,944	225		$341	7,680	$265	235
California	29,177	32,825			3,185	1,400	265
Colorado	44,531	23,133	40,700	18,566	11,591	6,053	17,660
Idaho	19,318	11,353					3,376
Illinois	1,770		2,500	500		600	340
Indiana	2,300	780			100	136	
Iowa	1,279	101					17
Kansas	14,016			8,500	60	2,400	265
Kentucky	20,593	59,967		450		1,000	
Maryland	1,733		7,966	2,700			2,657
Massachusetts	168,802	44,911			3,824		21,723
Michigan	13,312	15,416					2,505
Minnesota	4,215	34,139		323,267	32,108	925	24,935
Missouri	5,123	5,830			560	122	2,863
Montana	3,999	26,949					5,820
New Jersey	56,099	16,600			350	1,400	1,800
New Mexico	335	250		100			67
New York	118,296	313,101		348,502	322,643	174,489	50,626
Ohio	195,950	401,588	160	1,733	313,749	329,594	30,761
Oklahoma	10,580	4,326		1,016	21	616	2,670
Oregon	22,605	1,000		6,120			
Pennsylvania	292,751	281,020	274,645	24,917	159,903	117,727	101,240
South Dakota	24,907	23,379		80,140	1,150		8,760
Texas	140	38			1,015		4,500
Utah	16,989	980		2,728			17,601
Virginia		530					2,800
Washington	46,783	145,370		79,430	20,450		9,751
West Virginia	29,410	67,706		585	3,463	638	23,505
Wisconsin	17,165	35,751	66,138			11,714	5,675
Wyoming	3,754	1,560					
Total	1,174,876	1,604,016	404,197	899,595	881,902	649,079	404,219

State or Territory.	Riprap.	Crushed stone.			Other.	Total.
		Road making.	Railroad ballast.	Concrete.		
Alabama	$20,073			$56,000		$109,063
Arizona	24		$5,000	23,554	$5,000	131,716
Arkansas	36,888	$4,762	4,749	12,327	225	71,641
California	753	5,500	35,000	5,350	33	113,488
Colorado	1,025		7,500	17,674	1,170	189,603
Connecticut						(a)
Idaho					23	34,070
Illinois						5,710
Indiana	825					4,141
Iowa	9,000			4,029	30	14,456
Kansas				100	350	25,691
Kentucky	919			5,000	2,800	90,729
Maryland	20			3,150		18,226
Massachusetts	6,695	47,276		125,310	5,944	b 424,485
Michigan						31,233
Minnesota	4,870	34,098	6,811	17,887	323	483,578
Missouri	21,355			525	3,020	39,398
Montana	16,995				5,256	59,019
Nevada						(c)
New Jersey	200	9,191		27,010		112,650
New Mexico	650					1,402
New York	44,744	21,508	2,290	400,742	13,829	d 1,810,770
North Carolina						(e)
Ohio	38,246	13,844		47,333	26,173	1,402,131
Oklahoma	216			108	248	19,801
Oregon	150	500				f 30,375
Pennsylvania	31,872	111,557	123,741	57,305	18,392	d 1,595,070
South Dakota	7,191	241		8,388	2,420	156,576
Tennessee						(e)
Texas	7,015			27,650	113	40,471
Utah	5,291					43,589
Virginia		1,500	18,000	2,250		25,080
Washington	11,303				125,494	438,581
West Virginia	10,401	100	45,107	31,277	116	g 212,308
Wisconsin	17,677	3,893		31,016	625	189,654
Wyoming						5,314
Total	294,398	253,970	248,198	903,985	211,584	7,930,019

a Included in Massachusetts. b Includes Connecticut. c Included in Oregon. d Includes bluestone.
e Included in West Virginia. f Includes Nevada. g Includes North Carolina and Tennessee.

Building stone.—Sandstone for building, including rough and dressed stone, decreased in value from $3,349,519 in 1909 to $2,778,892 in 1910, a loss of $570,627. Ohio, Pennsylvania, and New York produced the most building stone.

Ganister.—Ganister, reported from Pennsylvania, Wisconsin, Colorado, Alabama, Maryland, Illinois, and Ohio, was valued at $404,197 in 1910, as against $240,409 in 1909, an increase of $163,788 in 1910.

Paving.—The total value of the paving stone increased $299,395, from $600,200 in 1909 to $899,595 in 1910. New York and Minnesota were large producers.

Curbing.—Sandstone for curbing was valued at $937,767 in 1909; in 1910 the value was $881,902, a decrease of $55,865. New York, Ohio, and Pennsylvania were the principal producers.

Flagging.—Ohio, New York, and Pennsylvania were the chief States producing sandstone flagging. Each State declined in production, the total decrease in the United States amounting to $306,204, from $955,283 in 1909 to $649,079 in 1910.

Rubble.—Rubble increased in value $38,326, from $365,893 in 1909 to $404,219 in 1910.

Riprap.—Sandstone sold for riprap increased in value from $276,640 in 1909 to $294,398 in 1910, a gain of $17,758.

Crushed stone.—There was an increase in value in crushed sandstone of $193,222, from $1,212,931 in 1909 to $1,406,153 in 1910. The quantity increased from 1,717,785 short tons in 1909 to 1,870,067 in 1910, a gain of 152,282 tons. The average price per ton in 1909 was 71 cents; in 1910 it was 75 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 sanstone 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 & Western Railway, and Hudson River. The output of bluestone increased in value from $1,446,402 in 1909 to $1,535,187 in 1910, or $88,785. The stone used for building, flagging, and curbing decreased in value, but that reported as disposed of as crushed stone and for unspecified purposes showed a large increase.

The increase in value of bluestone produced in New York was caused by the quarrying of a large quantity of bluestone in Ulster County that was used as rubble and as crushed stone in concrete in the building of dams for the New York City water-supply system. If it had not been for this fact the New York production as well as that of Pennsylvania would have decreased.

The following table shows the value and uses of the bluestone produced in New York and Pennsylvania in 1909 and 1910:

Value and uses of bluestone produced in New York and Pennsylvania in 1909 and 1910.

State.	Building purposes.	Flagging.	Curbing.	Crushed stone.	Other purposes.	Total value.
1909.						
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
1910.						
New York	$380,453	$164,061	$213,584	$308,101	$68,996	$1,135,195
Pennsylvania	138,207	107,846	98,558	47,823	7,558	399,992
Total	518,660	271,907	312,142	355,924	76,554	1,535,187

[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 in another chapter of Mineral Resources.

The total value of limestone produced in 1910 was $34,603,678, as compared with $32,070,401 in 1909, an increase in 1910 of $2,533,277. 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 dressed building stone, riprap, crushed stone, and paving blocks, and a slight increase in stone used in the manufacture of sugar. Decrease in value was reported for rough building stone, curbing, flagging, rubble, and stone not classified.

The principal States that produced limestone in 1910 were, in order of rank of value, Pennsylvania, Indiana, Ohio, Illinois, New York, and Missouri, each reporting over $2,000,000. In each of these States except Illinois, there was an increase.

The following table shows the value of limestone, by States, from 1906 to 1910, inclusive:

Value of limestone from 1906 to 1910, by States and Territories.

State or Territory.	1906	1907	1908	1909	1910
Alabama	$579,344	$694,699	$479,730	$700,642	$714,516
Arizona	40	64,975	[a] 50,130	([b])	([b])
Arkansas	48,844	52,207	61,971	112,468	84,280
California	80,205	177,333	237,320	283,869	590,990
Colorado	373,158	502,751	378,822	355,136	415,523
Connecticut	1,171	1,476	[c] 3,727	[c] 5,023	[d] 9,062
Florida	1,450	15,000	41,910	[e] 49,856	[e] 84,457
Georgia	16,042	22,278	8,495	34,593	24,236
Hawaii				([f])	
Idaho	12,600	15,900	36,000	([f])	19,423
Illinois	2,942,331	3,774,346	3,122,552	4,234,927	3,847,715
Indiana	3,725,565	3,624,126	3,643,261	3,749,239	4,472,241
Iowa	493,815	560,582	530,945	525,277	543,600
Kansas	849,203	813,748	403,176	892,335	768,739
Kentucky	795,408	891,500	810,190	903,874	978,809
Louisiana				([g])	([g])
Maine	2,000	1,350	([g])	([h])	([h])
Maryland	170,046	142,825	128,591	197,939	154,370
Massachusetts	10,750	1,837	1,950		([h])
Michigan	656,269	760,333	669,017	750,589	842,126
Minnesota	632,115	735,319	667,095	698,309	654,833
Missouri	1,988,334	2,153,917	2,130,136	2,111,283	2,360,604
Montana	141,082	124,690	134,595	154,064	169,836
Nebraska	276,381	312,630	330,570	293,830	338,731
New Jersey	221,141	274,452	172,000	224,017	224,709
New Mexico	125,493	193,732	([i])	[j] 140,801	[j] 227,657
New York	2,204,724	2,898,520	2,584,559	2,622,353	2,813,476
North Carolina	30,583	22,328	([k])	([k])	([k])
Ohio	3,025,038	3,566,822	3,519,557	4,020,046	4,357,432
Oklahoma	171,983	189,568	257,066	450,055	509,344
Oregon	7,480	5,750	6,230		3,594
Pennsylvania	4,865,130	5,821,275	4,057,471	5,073,825	5,394,611
Rhode Island	678	750	([h])	([h])	([h])
South Carolina					([k])
South Dakota	10,400	11,600	([l])	[m] 49,328	17,150
Tennessee	481,952	385,450	[n] 535,882	[n] 589,949	[o] 747,162
Texas	239,125	267,757	314,571	341,528	447,239
Utah	248,868	306,344	253,088	169,700	389,603
Vermont	14,728	23,126	20,731	18,839	25,250
Virginia	260,343	362,062	280,542	342,656	471,903
Washington	49,192	62,317	31,660	38,269	36,186
West Virginia	628,602	855,941	645,385	864,392	841,064
Wisconsin	891,746	1,027,095	1,102,009	1,047,044	979,522
Wyoming	53,783	18,920	[p] 31,168	24,346	43,687
Total	27,327,142	31,737,631	27,682,002	32,070,401	34,603,678

[a] Includes New Mexico.
[b] Included in New Mexico.
[c] Includes Maine and Rhode Island.
[d] Includes Maine, Massachusetts, and Rhode Island.
[e] Includes Louisiana.
[f] Included in South Dakota.
[g] Included in Florida.
[h] Included with Connecticut.
[i] Included with Arizona.
[j] Includes Arizona.
[k] Included with Tennessee.
[l] Included with Wyoming.
[m] Includes Hawaii and Idaho.
[n] Includes North Carolina.
[o] Includes North Carolina and South Carolina.
[p] Includes South Dakota.

The following table shows the value of limestone produced in the United States in 1909 and 1910, by States and Territories and uses:

Value of the production of limestone in the United States in 1909 and 1910, 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
Arizona							
Arkansas	23,655	74,413				650	
California	12,341						
Colorado							
Connecticut							90
Florida	6,955					684	14,400
Georgia	954						
Hawaii							
Idaho							
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
Louisiana							
Maine							
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 Mexico							
New York	168,569	37,355	3,080	2,574	315	83,198	63,526
North Carolina							
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
Rhode Island							
South Dakota							
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	
Washington							
West Virginia							
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 1909 and 1910, by States and Territories and uses—Continued.

1909.

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.

Value of the production of limestone in the United States in 1909 and 1910, by States and Territories and uses—Continued.

1910.

State or Territory.	Rough building.	Dressed building.	Paving.	Curbing.	Flagging.	Rubble.	Riprap.
Alabama	$1,901	$34,001	$4,500				$37,505
Arizona							
Arkansas	25,671	24,149				$910	
California	969	102					
Colorado							
Connecticut	1,614						
Florida		4,000				5,000	20,678
Georgia	548					817	
Idaho							
Illinois	50,958	9,963	128,413	$1,050	$825	236,315	48,315
Indiana	1,170,564	2,100,140	1,675	65,833	2,037	23,656	10,344
Iowa	76,147	9,687	3,119	225	1,110	42,278	57,334
Kansas	47,856	83,785	59,815	1,666	2,168	18,667	40,637
Kentucky	107,676	58,700	8,298	26,510	161	8,059	29,695
Louisiana							
Maine							
Maryland	4,944	1,322	384				
Massachusetts							
Michigan	3,552		35,500			2,205	908
Minnesota	127,822	137,710	1,480	4,625	6,386	59,421	28,557
Missouri	129,837	443,524	10,700	5,873	8,244	271,599	194,504
Montana	8,270			117		290	
Nebraska	1,892	19,643	23,858	5,500		3,939	43,065
New Jersey	1,540					735	
New Mexico	200						1,400
New York	95,303	42,568	16,492	1,575	750	44,235	24,115
North Carolina							
Ohio	55,942	3,230	300	982		26,512	433,007
Oklahoma	76,375	475	50,030	18,686	160	3,318	17,772
Oregon			2,000				
Pennsylvania	103,295	118	67,069	1,850	1,108	3,314	1,714
Rhode Island							
South Carolina							
South Dakota	2,200						
Tennessee	9,404	6,555	13,043	3,555	1,400	4,274	75,176
Texas	46,573	1,660		327	1,302	2,362	96,647
Utah	50,668	500				400	133,000
Vermont	3,440		180	150		2,500	
Virginia	125		45	750		3,188	1,805
Washington							
West Virginia	160	40				775	200
Wisconsin	70,285	13,278	37,936	26,507	11,156	54,033	51,794
Wyoming	843	300				1,200	
Total	2,276,574	2,995,450	464,837	165,781	36,807	820,002	1,348,172

Value of the production of limestone in the United States in 1909 and 1910, by States and Territories and uses—Continued.

State or Territory.	Crushed stone.			Flux.	Sugar factories.	Other.	Total.
	Road making.	Railroad ballast.	Concrete.				
Alabama	$64,872	$5,842	$16,199	$545,988		$3,708	$714,516
Arizona							(a)
Arkansas	3,600	24,500	4,500			950	84,280
California	314,786		5,550	136,132	$116,091	17,360	590,990
Colorado		1,640		328,549	83,767	1,567	415,523
Connecticut	206			2,391		4,851	b 9,062
Florida	30,250	1,400	19,500			3,629	c 84,457
Georgia	326	3,406	1,509	17,630			24,236
Idaho	1,000				18,423		19,423
Illinois	954,409	520,132	953,502	854,615	21,004	68,214	3,847,715
Indiana	551,021	125,498	133,186	203,718	965	83,604	4,472,241
Iowa	57,168	35,434	255,233	625		5,240	543,600
Kansas	72,965	271,023	166,996	142		3,019	768,739
Kentucky	288,611	317,221	110,602	9,627		13,649	978,809
Louisiana							(d)
Maine							(e)
Maryland	96,453	6,662	39,537	4,334		734	154,370
Massachusetts							(e)
Michigan	110,184	42,358	178,318	100,149	69,647	299,305	842,126
Minnesota	31,665	750	253,082	378	2,812	145	654,833
Missouri	509,559	204,988	479,394	51,775	8,822	41,785	2,360,604
Montana	150			151,576		9,433	169,836
Nebraska	10,000		229,164		1,651	19	338,731
New Jersey	16,191		6,615	199,532		94	224,707
New Mexico	7,225	201,153	9,367	6,664	1,648		f 227,657
New York	985,240	545,615	341,979	469,193		246,411	2,813,476
North Carolina							(g)
Ohio	1,300,348	789,130	330,190	1,263,605	6,057	148,129	4,357,432
Oklahoma	20,908	162,932	156,784			1,904	509,344
Oregon	800		200	594			3,594
Pennsylvania	409,643	495,002	455,301	3,735,060		121,137	5,394,611
Rhode Island							(e)
South Carolina							(g)
South Dakota	9,200		5,750				17,150
Tennessee	298,330	123,530	102,788	100,865		8,242	h 747,162
Texas	92,514	24,244	140,454	39,006		2,150	447,239
Utah			5,100	186,466	12,656	813	389,603
Vermont	16,840		3,750	345		4,045	25,250
Virginia	20,056	108,129	36,849	294,668		6,288	471,903
Washington	1,077			28,145	480	6,484	36,186
West Virginia	3,449	229,462	20,400	574,693		11,885	841,064
Wisconsin	322,671	48,380	297,051	39,268		7,163	979,522
Wyoming			22,364		18,377	603	43,687
Total	6,595,717	4,288,431	4,781,214	9,345,733	362,400	1,122,560	34,603,678

a Included in New Mexico.
b Includes Maine, Massachusetts, and Rhode Island.
c Includes Louisiana.
d Included in Florida.
e Included in Connecticut.
f Includes Arizona.
g Included in Tennessee.
h Includes North Carolina and South Carolina.

Building stone.—Limestone for building purposes, including rough and dressed stone, sold by producers increased in value $474,756, from $4,797,268 in 1909 to $5,272,024 in 1910. The increase was confined entirely to the dressed limestone, which increased in value from $2,226,942 in 1909 to $2,995,450 in 1910, while the rough stock decreased from $2,570,326 in 1909 to $2,276,574 in 1910.

The output of building stone in Indiana was valued at $3,270,704 in 1910, which was a little more than 62 per cent of the total for the United States, and therefore more than the proportion produced in 1909, which was not quite 54 per cent. The gain in value for Indiana in 1910 was $682,000. 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 131,590 short tons of stone, valued at $75,906, used for riprap, crushed stone, furnace flux, etc., the total quantity and value of limestone produced in Lawrence County in 1910 was 5,778,660 cubic feet, valued at $1,841,233; Monroe County produced, exclusive of 70,655 short tons, valued at $44,224, for flux etc. 3,960,148 cubic feet of other stone, valued at $1,265,287. The total for the two counties, exclusive of the flux, etc., was therefore 9,738,808 cubic feet, valued at $3,106,520. In 1909 the total output of building stone from these two counties was 9,411,871 cubic feet, valued at $2,479,631, a gain in 1910 of 326,937 cubic feet in quantity and of $626,889 in value. In 1909 the quantity of stone sold for other than building purposes from these two counties, not included in the figures above, was 252,272 short tons, valued at $128,562, a decrease in 1910 in this class of material of 50,027 short tons in quantity and of $8,432 in value. The low price per ton was due to the low price obtained for waste stone sold for flux. In 1909 the total quantity for the two counties included 6,603,992 cubic feet of stone sold rough, of which 4,721,424 cubic feet, valued at $893,694, were for Lawrence County and 1,882,568 cubic feet, valued at $295,158, were for Monroe County. In 1910 there were 5,650,811 cubic feet of rough stone sold, a decrease from 1909 of 953,181 cubic feet of rough stock. In 1909 the two counties reported 2,807,879 cubic feet of dressed stone, of which 1,720,059 cubic feet, valued at $784,501, were from Lawrence County and 1,087,820 cubic feet, valued at $506,278, from Monroe County. In 1910 the quantity of dressed stone sold was 4,087,997 cubic feet, an increase of 1,280,118 cubic feet over 1909. In 1910 the total value of dressed stone for Lawrence County was $1,027,212, and for Monroe County $922,689—a gain in 1910 of $242,711 for Lawrence County and of $416,411 for Monroe County. Most of this stone was for building, but there was included a small quantity for rubble, curbstone, and flagstone. The average price per cubic foot for rough stone in 1909 was 18 cents, and in 1910 20 cents; for dressed stone in 1909 it was 46 cents, and in 1910 48 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., 1901–1910.

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 6,441,483	1,678,195	a 2,970,388	801,436	a 9,411,871	2,479,631
	b 145,672	71,637	b 106,600	56,925	b 252,272	128,562
1910	a 5,778,660	1,841,233	a 3,960,148	1,265,287	a 9,738,808	3,106,520
	b 131,590	75,906	b 70,655	44,224	b 202,245	120,130

a Cubic feet. b Short tons.

The following table shows the production of Bedford oolitic limestone in Lawrence and Monroe counties, Ind., in 1909 and 1910, by uses:

Production of Bedford oolitic limestone in Lawrence and Monroe Counties, Ind., in 1909 and 1910, by uses.

1909.

County.	Building.						Other uses.a		Total value.
	Rough.		Dressed.		Total.				
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
	Cubic feet.		*Cubic feet.*		*Cubic feet.*		*Short tons.*		
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	....	$0.18	....	$0.46	....	$0.26	....	$0.51	....

1910.

County.	Rough Quantity.	Rough Value.	Dressed Quantity.	Dressed Value.	Total Quantity.	Total Value.	Other uses Quantity.	Other uses Value.	Total value.
Lawrence	3,627,512	$814,021	2,151,148	$1,027,212	5,778,660	$1,841,233	131,590	$75,906	$1,917,139
Monroe	2,023,299	342,598	1,936,849	922,689	3,960,148	1,265,287	70,655	44,224	1,309,511
Total	5,650,811	1,156,619	4,087,997	1,949,901	9,738,808	3,106,520	202,245	120,130	3,226,650
Average price	....	$0.20	....	$0.48	....	$0.32	....	$0.59	....

a Used for crushed stone, flux, curbing, flagging, etc.

Missouri ranked next to Indiana in output of building limestone, the value of the output in 1910 being $573,361, as against $641,542 for 1909, a decrease in 1910 of $68,181. 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 1910 was $382,756, as compared with $370,002 in 1909, an increase of $12,754. The output in 1910 consisted of 502,161 cubic feet of building stone, valued at $347,244, an average of 69.1 cents per cubic foot; of curbing, valued at $1,767; of flagging, valued at $7,229; of rubble, valued at $2,945; and of stone for miscellaneous uses, valued at $23,571. All of these items except rubble and stone for uses not specified showed an increase in 1910.

The following table shows the production of limestone near Carthage, Jasper County, Mo., in 1908, 1909, and 1910, by uses:

Production of limestone at Carthage, Jasper County, Mo., in 1908, 1909, and 1910, 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
1910	10	502,161	347,244	1,767	7,229	2,945	23,571	382,756

[a] Includes stone used for monumental work, crushed stone, stone sold to glass factories, blast furnaces, sugar factories, etc.

Another limestone of increasing importance to the building trade in the Central States is the oolitic limestone quarried near Bowling Green, Ky. It may be of interest to present here for the first time the quantity and value of this limestone produced in 1909 and 1910, and accordingly the following table has been prepared:

Production of limestone in Warren County, Ky., by uses, 1909–10.

	Rough building.		Dressed building.		Crushed stone.		Other.[a]	Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Value.	
	Cubic feet.		*Cubic feet.*		*Short tons.*			
1909	203,120	$60,936	74,482	$62,989	46,725	$22,013	$33,704	$179,642
1910	204,602	56,141	90,100	57,350	108,183	47,532	5,584	166,607

[a] Curbing, flagging, fluxing, and monumental stone.

Paving.—Limestone for paving increased in value from $188,680 in 1909 to $464,837 in 1910, or $276,157. Illinois, Pennsylvania, Kansas, Oklahoma, Wisconsin, and Michigan produced most of the limestone used for paving in 1910.

Curbing.—There was a decrease of $48,359 in the value of the curbstone output, from $214,140 in 1909 to $165,781 in 1910. Indiana, Kentucky, Wisconsin, and Oklahoma furnished most of this material in 1910.

Flagging.—A decrease of $4,536 marked the limestone output of flagging in 1910, from $41,343 in 1909 to $36,807 in 1910. Most of this stone was from Wisconsin, Missouri, and Minnesota.

Rubble.—Rubble decreased in value $408,443, from $1,228,445 in 1909 to $820,002 in 1910. Missouri, Illinois, Minnesota, and Wisconsin reported the largest production.

Riprap.—Riprap increased in value $265,938, from $1,082,234 in 1909 to $1,348,172 in 1910. Ohio, Missouri, and Utah produced most of this stone in 1910.

Crushed stone.—Crushed limestone used in road making, railroad ballast, concrete, etc., had a larger value than any other limestone product. In 1910 this output was 28,663,980 tons short, valued at $15,665,362, an increase of 2,371,215 short tons in quantity and of $612,609 in value for 1910 as compared with 1909, when the figures were 26,292,765 short tons, valued at $15,052,753.

In 1910 the total output was divided into 10,947,794 short tons, valued at $6,595,717, for road making; 9,340,573 short tons, valued at $4,288,431, for railroad ballast; and 8,375,613 short tons, valued at $4,781,214, for concrete, which, compared with the itemized output for 1909—road making, 11,413,794 tons, valued at $7,294,248; railroad ballast, 7,273,100 tons, valued at $3,308,430; concrete, 7,605,871 tons, valued at $4,450,075—was a decrease of 466,000 tons in quantity and of $698,531 in value for road making, an increase of 2,067,473 tons in quantity and of $980,001 in value for railroad ballast, and an increase of 769,742 tons in quantity and of $331,139 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 55 cents in 1910 compared with 57 cents in 1909.

Illinois ranked first in 1910 in the production of crushed limestone; Ohio ranked second.

Furnace flux.—Next to crushed stone, limestone sold for furnace flux showed the largest value. The production in 1909 was 15,772,863 long tons, valued at $7,921,807; in 1910 the production was 18,203,882 long tons, valued at $9,345,733, an increase of 2,431,019 tons in quantity and of $1,423,926 in value. The average price per ton was 50 cents in 1909 and 51 cents in 1910. Pennsylvania, Ohio, Illinois, West Virginia, Alabama, New York, Virginia, and Colorado, were the principal producers.

The following table shows the production of limestone for smelter, open hearth, and blast furnace flux in 1909 and 1910, by States, in long tons:

Production of furnace flux, etc., in 1909 and 1910, by States, in long tons.

State or Territory.	1909		1910	
	Quantity.	Value.	Quantity.	Value.
Alabama	974,650	$512,585	1,022,381	$545,988
Arizona	(a)	(a)	(a)	(a)
California	13,769	29,904	123,421	136,132
Colorado	462,291	267,806	531,903	328,549
Connecticut	(a)	(a)	(a)	(a)
Georgia	18,850	15,696	24,949	17,630
Illinois	1,820,590	714,631	2,166,372	854,615
Indiana	369,938	190,809	367,441	203,718
Iowa			971	625
Kansas	528	493	420	142
Kentucky	18,919	10,804	16,846	9,627
Maryland			6,909	4,334
Michigan	197,061	91,915	223,830	100,149
Minnesota			562	378
Missouri	43,909	31,075	71,310	51,775
Montana	232,535	127,532	276,642	151,576
Nebraska	10,000	15,000		
New Jersey	402,333	206,435	374,993	199,532
New York	580,802	343,891	789,740	469,193
North Carolina	(b)	(b)		
Ohio	2,161,681	1,130,082	2,421,427	1,263,605
Oregon			412	594
Pennsylvania	6,593,822	3,165,872	7,545,094	3,735,060
Rhode Island	(a)	(a)	(a)	(a)
South Carolina			(a)	(a)
Tennessee	c 157,789	c 87,432	182,561	100,458
Texas	67,821	40,819	56,171	39,006
Utah	177,107	126,915	270,105	186,466
Vermont	249	250	345	345
Virginia	388,746	213,444	540,324	294,668
Washington	30,906	31,317	28,710	28,145
West Virginia	900,993	492,497	1,072,193	574,693
Wisconsin	110,212	56,075	74,268	39,268
Other States	d 37,362	d 18,528	e 13,582	e 9,462
Total	15,772,863	7,921,807	18,203,882	9,345,733
Average price per ton		.50		.51

a Included in other States.
b Included in Tennessee.
c Includes North Carolina.
d Includes Arizona, Connecticut, and Rhode Island.
e Includes Arizona, Connecticut, Rhode Island, and South Carolina.

Other uses.—Stone for other uses includes stone quarried and used by sugar refiners in several States, 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. Stone reported as sold to sugar refiners increased in value from $291,287 in 1909 to $362,400 in 1910, a gain of $71,113. The quantity of mineral wool produced was 4,581 short tons, valued at $68,708. The whole output was reported by three producers in Madison County, Ind. The total output of stone for these various uses decreased in value $129,884, from $1,252,444 in 1909 to $1,122,560 in 1910.

MARBLE.

Total value.—The figures for marble production here presented include, for some of the States, the value of serpentine (verde antique marble) and "onyx" marble. The serpentine included is that form 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 1910 the commercial output of marble came from Vermont, Georgia, Tennessee, New York, Colorado, Alabama, Massachusetts, Pennsylvania, California, Maryland, Alaska, North Carolina, Arizona, Kentucky, West Virginia, Utah, New Mexico, and Washington, named in order of value of output.

The marble output in the United States was valued in 1909 at $6,548,905; in 1910 it was valued at $6,992,779, a gain of $443,874.

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 1906 to 1910, inclusive, by States and Territories:

Value of marble produced in the United States, 1905–1909, by States and Territories.

State or Territory.	1906	1907	1908	1909	1910
Alabama	$85,000	$85,475	a $118,580	b $212,462	c $255,664
Alaska	(d)	38,110	e 103,888	f 46,900	(g)
Arizona				(h)	
Arkansas	16,900				
California	103,048	183,285	60,408	89,392	i 112,339
Colorado			(j)	k 488,311	l 488,173
Georgia	919,356	864,757	916,281	766,449	953,917
Idaho		(h)			
Kentucky		12,500	(m)	(m)	(m)
Maryland	176,495	98,918	n 79,317	(m)	(o)
Massachusetts	271,934	212,438	175,648	243,711	224,088
Missouri	(p)	(p)	(m)		
Nevada	5,000				
New Mexico	500	q 7,535	(j)	r 5,390	(s)
New York	557,954	911,951	706,858	402,729	484,732
North Carolina			(t)	(m)	(m)
Oklahoma		16,805			
Oregon				(s)	
Pennsylvania	171,632	118,539	102,747	186,037	u 182,514
Tennessee	635,821	688,148	790,233	613,741	728,502
Texas				(h)	(s)
Utah	1,400	2,500	(j)	(s)	(s)
Vermont	4,576,913	4,596,724	4,679,960	3,493,783	3,562,850
Washington	59,985	(h)		(j)	(g)
West Virginia				(m)	(m)
Wyoming	1,000				
Total	7,582,938	7,837,685	7,733,920	6,548,905	6,992,779

a Includes Kentucky and Missouri.
b Includes Kentucky, Maryland, North Carolina, and West Virginia.
c Includes Kentucky, North Carolina, and West Virginia.
d Included in Washington.
e Includes Colorado, New Mexico, and Utah.
f Includes Washington.
g Included in California.
h Included in New Mexico.
i Includes Alaska and Washington.
j Included in Alaska.
k Includes Oregon and Utah.
l Includes Arizona, New Mexico, and Utah.
m Included in Alabama.
n Includes North Carolina.
o Included in Pennsylvania.
p Included in limestone.
q Includes Idaho and Washington.
r Includes Arizona and Texas.
s Included in Colorado.
t Included in Maryland.
u Includes Maryland.

Value of the marble produced, 1909 and 1910, by States and Territories and uses.

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

1910.

State or Territory.	Rough. Building.	Rough. Monumental.	Rough. Other uses.	Dressed. Building.	Dressed. Monumental.	Dressed. Ornamental.	Dressed. Interior decoration.	Dressed. Other uses.	Total.
Alabama	$45,209		$16,875			$5,750	$183,274	$4,556	*i* $255,664
Alaska									(*j*)
Arizona									(*g*)
California	93,259	$1,680	5,700				10,000	1,700	*k* 112,339
Colorado	250	180	400	$307,743	$15,800		163,800		*l* 488,173
Georgia	310,000	472,570	106,347		52,000		13,000		953,917
Kentucky									(*e*)
Maryland									(*m*)
Massachusetts	2,595		8,570	26,217	45,050		128,331	13,325	224,088
New Mexico									(*g*)
New York	39,540	53,543	6,831	327,933	33,885		1,500	21,500	484,732
North Carolina									(*e*)
Pennsylvania	68,416		8,142	63,956	6,000		36,000		*n* 182,514
Tennessee	58,077	38,023	8,573	40,000	2,000	7,200	552,741	21,888	728,502
Utah									(*g*)
Vermont	276,700	325,000	152,000	697,900	1,125,250	25,000	913,000	48,000	3,562,850
Washington									(*j*)
West Virginia									(*e*)
Total	894,046	890,996	313,438	1,463,749	1,279,985	37,950	2,001,646	110,969	6,992,779

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.
i Includes Kentucky, North Carolina, and West Virginia.
j Included in California.
k Includes Alaska and Washington.
l Includes Arizona, New Mexico, and Utah.
m Included in Pennsylvania.
n Includes Maryland.

The following table shows the various uses to which the marble quarried in 1905, 1906, 1907, 1908, 1909, and 1910 was put:

Distribution and value of output of marble, 1905–1910, among various uses.

Use.	1905	1906	1907	1908	1909	1910
Sold by producers in rough state	$2,987,542	$1,795,169	$1,697,891	$1,455,980	$2,330,336	$2,098,480
Dressed for—						
Building	1,168,450	1,559,925	1,905,145	2,329,438	1,293,019	1,463,749
Ornamental purposes	13,643	44,523	25,050	25,506	24,695	37,950
Monumental work	1,170,279	2,214,872	2,044,000	1,843,426	1,184,672	1,279,985
Interior decoration in buildings	1,682,651	1,722,445	1,900,952	1,943,750	1,557,783	2,001,646
Other uses	106,506	246,004	264,647	135,820	158,400	110,969
Total	7,129,071	7,582,938	7,837,685	7,733,920	6,548,505	6,992,729

Building stone.—The value of building marble, rough and dressed, as sold by the producer, was $2,357,795 in 1910, a decrease of $523,472 from the value for 1909, which was $2,881,267. The total for 1910 included $894,046 for rough and $1,463,749 for dressed building stone; in 1909 the rough building marble sold was valued at $1,588,248 and the dressed building stone at $1,293,019, a decrease in 1910 of $694,202 for rough stock and an increase of $170,730 for dressed marble.

Vermont produces most of the building marble, the value of whose output in 1910 was $974,600, or 41.3 per cent of the total. This was chiefly dressed stone. The percentage of the total for Vermont in 1909 was 44.5 and the value was $1,282,444.

The Georgia output, which was rough stone, was valued at $310,000 and represented 13.1 per cent of the total.

Monumental stone.—Monumental marble was valued at $1,756,198 in 1909 and at $2,170,981 in 1910, an increase of $414,783 for 1910. In 1909 the value of rough stock was $571,526 and of dressed monumental stone, $1,184,672; the corresponding figures for 1910 were $890,996 for rough monumental stock, and $1,279,985 for dressed monumental stone, an increase in 1910 of $319,470 in value of rough stock and of $95,313 for dressed stone. Vermont, with an output valued at $1,450,250, produced 66.8 per cent of the total monumental marble; Georgia, with 24.2 per cent, ranked second; and New York, producing about 4 per cent, ranked third. The Vermont stone was chiefly dressed stone; the Georgia output was principally rough stone; and the New York material was almost evenly divided between rough stone and dressed stone.

Interior work.—Vermont, Tennessee, Alabama, Colorado, and Massachusetts produced most of the marble used for interior decorations, the total value for 1910 being $2,001,646, as against $1,557,783 for 1909, a gain in 1910 of $443,863. The Vermont output represents 45.6 per cent, the Tennessee output 27.6 per cent, and the Alabama output 9.2 per cent of the total marble produced for interior work.

Other marble.—Rough stone for other uses 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 1910 was valued at $424,407, as compared with $328,962 in 1909, an increase of $95,445.

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 between 1882 and 1899 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.

——— Stone. Mineral Resources U. S. for 1909, pt. 2, pp. 569–608. 1911.

BUTTS, CHARLES. Variegated marbles southeast of Calera, Shelby County, Ala. Bull. 470–G, pp. 3–5. 1911.

CLAPP, F. G. Limestones of southwestern Pennsylvania. Bull. 249. 1905.

DALE, T. N. The slate belt of eastern New York and western Vermont. Nineteenth 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.

——— Supplementary notes on the commercial granites of Massachusetts. Bull. 470–G, pp. 6–54. 1911.

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.)

Paige, Sidney. Marble in Chiricahua Mountains, Arizona. Bull. 380, pp. 299–311. 1909.

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. 661–692, 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, pt. 2, pp. 557–568; Stone, by E. F. Burchard, pt. 2, pp. 569–608.
1910. Slate, by A. T. Coons, pt. 2; Stone, by E. F. Burchard, pt. 2.

ABRASIVE MATERIALS.

By W. C. Phalen.

INTRODUCTION.

Abrasive materials fall naturally into two classes—natural abrasives and artificial abrasives. The production of artificial abrasives has shown great increase since its beginning, less than 15 years ago, and the value of these abrasives produced in this country during the last two years has exceeded that of the natural abrasives.

All branches of the abrasive industry showed notable growth in 1910 except the millstone and the grindstone industries. The grindstone industry, however, is in a healthy condition, even though it showed a slight decline in 1910 as compared with 1909. It must be recalled that the market for millstones has been curtailed in recent years because of the introduction of superior forms of grinding machinery, such as rolls and ball mills, and the rolling-mill process is now used almost exclusively in grinding wheat. Some corn and mustard mills in the Southern States still use handmade millstones, and a part of the millstone product is sold to manufacturers of cement and talc, and to grinders of quartz, feldspar, and mineral paints.

The total estimated value of all the abrasive materials consumed in the United States for the five years 1906 to 1910 is given in the following table:

Total value of all abrasive materials consumed in the United States, 1906–1910.

Year.	Natural abrasives.	Artificial abrasives.	Imports.	Total value.
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
1910	1,406,805	1,604,030	1,223,827	4,234,662

NATURAL ABRASIVES.

Under the head of natural abrasives there are included in this report the following materials: (1) Millstones and burrstones, (2) grindstones and pulpstones, (3) oilstones and scythestones, (4) emery, (5) abrasive garnet, (6) infusorial earth and tripoli, and (7) pumice. This report gives the statistics of only that part of the production of natural abrasives that properly comes under the abrasive industry except as indicated below; 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. There is difficulty in separating that portion of the production of tripoli and infusorial earth which is used as an abrasive from that which is not, hence the production of these commodities is given in full. 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 used extensively as a packing material for furnaces, steam pipes, and boilers, and as a fireproof building material. Similarly, tripoli, in addition to being ground and used as an abrasive, is used as a filtering medium. The entire output of millstones, pumice, emery, and garnet (except gem garnet) is used in the abrasive industry.

In the report for 1909 there were included detailed descriptions of the following industries: (1) The millstone industry in New York and Virginia, (2) the scythestone industry in New Hampshire, (3) the abrasive garnet industry in New York, and (4) the tripoli industry in Missouri; and from year to year detailed descriptions have been given of other industries. The descriptions specifically referred to above will not be repeated here; they can be found in the report for 1909.

Natural abrasives were produced in 21 States in 1910. A list of the States, with the materials produced by each, is given below. The changes that have taken place since 1909 are as follows: Georgia produced no infusorial earth in 1910, but Maryland reported a small production and is again placed on the list. Idaho produced no pumice for abrasive use, but a small production was reported from Kansas. The number of States producing abrasive materials is, therefore, the same as in 1909, namely, 21.

Alabama: Millstones.
Arkansas: Oilstones.
California: Infusorial earth.
Colorado: Grindstones.
Connecticut: Infusorial earth.
Illinois: Tripoli.
Indiana: Oilstones.
Kansas: Pumice.
Maryland: Infusorial earth.
Massachusetts: Emery and infusorial earth.
Michigan: Grindstones and scythestones.
Missouri: Tripoli.
Nebraska: Pumice.
New Hampshire: Scythestones, garnet.
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 and infusorial earth.
West Virginia: Grindstones.

The following table gives the value of all the natural abrasive materials produced in the United States from 1906 to 1910, inclusive:

Value of natural abrasives produced in the United States, 1906–1910.

Kind of abrasive.	1906	1907	1908	1909	1910
Oilstones and scythe stones	$268,070	$264,188	$217,284	$214,019	$228,694
Grindstones and pulpstones	744,894	896,022	536,095	804,051	796,294
Burrstones and millstones [a]	48,590	31,741	31,420	35,393	28,217
Pumice	16,750	33,818	39,287	33,439	94,943
Infusorial earth and tripoli	72,108	104,406	97,442	122,348	130,006
Abrasive quartz and feldspar	121,671	126,582	79,146	([b])	([b])
Garnet	157,000	211,686	64,620	102,315	113,574
Corundum and emery	44,310	12,294	8,745	18,185	15,077
Total	1,473,393	1,680,737	1,074,039	1,329,750	1,406,805

[a] The figures represent the value of millstones only.
[b] See chapter on quartz and feldspar.

BURRSTONES AND MILLSTONES.

PRODUCTION.

The production of burrstones and millstones in the United States in 1910 was valued at $28,217, a decrease of $7,176 as compared with 1909. The stones came from New York, Virginia, North Carolina, Pennsylvania, and Alabama, but the production of the last two States mentioned was almost negligible. The production of millstones in New York increased but little in 1910 as compared with 1909, and the output of North Carolina decreased slightly. The production of Virginia declined very materially. The output of this State when examined for several years—say, since 1905—has shown great unsteadiness.

The millstone industry in New York and Virginia has been described in previous volumes of Mineral Resources of the United States, to which the reader is referred.

The following table gives, by States, the value of the millstones, burrstones, chasers, and drag or rider stones produced from 1906 to 1910, inclusive:

Value of millstones produced in the United States, 1906–1910, by States.

State.	1906	1907	1908	1909	1910
New York	$28,848	$23,072	$18,341	$13,138	$13,753
Virginia	15,611	4,684	7,954	22,255 (Virginia, North Carolina, Pennsylvania, Alabama)	5,273
North Carolina	1,507	1,969	4,052		9,191 (North Carolina, Pennsylvania, Alabama)
Pennsylvania	2,624	2,016	1,073		
Alabama					
Total	48,590	31,741	31,420	35,393	28,217

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, 1880–1910.

1880	$200,000	1896	$22,567
1881	150,000	1897	25,932
1882	200,000	1898	25,934
1883	150,000	1899	28,115
1884	150,000	1900	32,858
1885	100,000	1901	57,179
1886	140,000	1902	59,808
1887	100,000	1903	52,552
1888	81,000	1904	37,338
1889	35,155	1905	37,974
1890	23,720	1906	48,590
1891	16,587	1907	31,741
1892	23,417	1908	31,420
1893	16,639	1909	35,393
1894	13,887	1910	28,217
1895	22,542		

IMPORTS.

The value of the burrstones and millstones imported into the United States in 1910 amounted to $34,763, as compared with a value of $22,590 in 1909. From a period of decline from 1906 to 1908 the imports are now increasing, the last two years having showed a steady increase. The value of the imports of finished millstones appears to be very unsteady. In 1909 it amounted to ess than $500, and in 1906 it fell to less than $300. In 1910 it was $1,023. The value of the imports of burrstones and millstones, both rough and prepared, from 1906 to 1910 is given in the following table:

Value of burrstones and millstones imported and entered for consumption in the United States, 1906–1910.

Year.	Rough.	Made into millstones.	Total.	Year.	Rough.	Made into millstones.	Total.
1906	$32,921	$277	$33,198	1909	$22,125	$465	$22,590
1907	26,431	877	27,308	1910	33,740	1,023	34,763
1908	16,075	2,567	18,642				

GRINDSTONES AND PULPSTONES.

PRODUCTION.

The value of the grindstones and pulpstones produced in the United States in 1910 amounted to $796,294. There was a decline of $7,757 in 1910 as compared with 1909. The industry appears to be in a healthy condition, although it did not reach the maximum figure reported for 1907. The level about which the value of the output has hovered during the last two years indicates a substantial advance as compared with the value of the product five years ago. In the following table is given the value of grindstones and pulpstones produced from 1906 to 1910, inclusive:

Value of the production of grindstones and pulpstones, 1906–1910.

	1906	1907	1908	1909	1910
Grindstones	$694,894	$846,522	$495,495	$768,651	$746,294
Pulp stones	50,000	49,500	40,600	35,400	50,000
Total	744,894	896,022	536,095	804,051	796,294

In the following table is given the value of grindstones and pulpstones produced in the United States from 1906 to 1910, by States. The States which produced grindstones are Ohio, Michigan, West Virginia, and Colorado. The first State mentioned also manufactured pulpstones. Ohio maintained the leading position in the industry, as usual, in 1910, producing more than seven times as much as all the other States combined. The production of Michigan was important. The output of West Virginia, though small, showed a fair increase as compared with that of the preceding year. There was also a gain in the production reported from Colorado.

Value of grindstones and pulpstones produced in the United States, 1906–1910, by States.

State.	1906	1907	1908	1909	1910
Ohio	$644,720	$764,276	$482,128	$679,930	$699,033
Michigan	78,500	(a)	(a)	(a)	(a)
West Virginia and Colorado	b 21,674	c 131,746	53,967	c 124,121	c 97,261
Total	744,894	896,022	536,095	804,051	796,294

a Included with West Virginia, etc.
b Including a small production from Wyoming.
c Includes Michigan.

The value of the production of pulpstones and grindstones in the United States from 1880 to 1910, inclusive, is shown in the following table:

Value of grindstones and pulpstones produced in the United States, 1880–1910.

1880	$500,000	1896	$326,826
1881	500,000	1897	368,058
1882	700,000	1898	489,769
1883	600,000	1899	675,586
1884	570,000	1900	710,026
1885	500,000	1901	580,703
1886	250,000	1902	667,431
1887	224,400	1903	721,446
1888	281,800	1904	881,527
1889	439,587	1905	777,606
1890	450,000	1906	744,894
1891	476,113	1907	896,022
1892	272,244	1908	536,095
1893	338,787	1909	804,051
1894	223,214	1910	796,294
1895	205,768		

IMPORTS.

The value of the imports of grindstones and pulpstones increased in 1910, amounting to $106,596, as compared with $99,153 in 1909.

Value of pulpstones and grindstones imported and entered for consumption in the United States, 1906–1910.

1906	$134,136	1909	$99,153
1907	111,495	1910	106,596
1908	80,382		

CANADIAN PRODUCTION.

The value of the Canadian production of grindstones in 1910 amounted to $43,936, as compared with $54,664 in 1909. In the following table is given the value of the Canadian production of grindstones during the last five years:

Value of production of grindstones in Canada, 1906–1910.

1906	$61,624	1909	$54,664
1907	60,376	1910	43,936
1908	45,128		

OILSTONES AND SCYTHESTONES.

PRODUCTION.

The production of oilstones and scythestones in the United States during 1910 amounted to $228,694, as compared with $214,019 in 1909. Oilstones were produced in Arkansas, Indiana, and Ohio, the production of Arkansas amounting to nearly 75 per cent of the whole. Scythestones were produced in New Hampshire, Vermont, Michigan, and Ohio, the production of the first State named amounting to nearly 65 per cent of the whole. The following table gives the value of oilstones and scythestones produced in the United States from 1891 to 1910, inclusive:

Value of oilstones and scythestones produced in the United States, 1891–1910.

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	1910	228,694

IMPORTS AND EXPORTS.

The value of the imports of hones, whetstones, and oilstones amounted to $45,819 in 1910, as compared with $68,018 in 1909. The imports are comparable with those of 1908 but fall well below the imports of any other year since 1905. The imports have fluctuated considerably during the last three years, but their average is greatly below what it was prior to 1908. The balance of trade of the United States is, however, strengthened by the exportation of Arkansas oilstones and New Hampshire scythestones. The value of the importation of individual commodities can not be given, as no separate record of them is kept. In the following table is given the combined value of all kinds of hones, oilstones, and whetstones imported into the United States during the last five years:

Value of imports of hones, oilstones, and whetstones, 1906–1910.

1906	$83,863	1909	$68,018
1907	89,939	1910	45,819
1908	44,304		

CORUNDUM AND EMERY.

The United States has produced no corundum since 1906, and the production given in the following table since that time is that of emery only, which comes from Chester, Hampden County, Mass., and from near Peekskill, Westchester County, N. Y. The domestic production of emery in 1910, which was valued at $15,077, amounted to less than 2 per cent of the total importations, as compared with a little more than 5 per cent in 1909. One of the reasons for the small domestic production is doubtless the cheaper available supply of good material from Greece and Turkey, whence emery is imported crude as ballast. The importation as ballast was formerly carried on to escape the import duty, but this duty was removed in 1909 from both grain and manufactured emery.

The production of emery in the United States in 1910, as stated above, amounted to 1,028 short tons, valued at $15,077. This was a decrease, as compared with the production of 1909, of 552 tons in quantity and of $3,108 in value. The value of the material per ton was $14.67. The figures represent the value of the material as shipped from the mines, where it undergoes a rough sorting or cobbing. All the Peekskill, N. Y., emery and some of the Chester, Mass., product is shipped away for manufacture into the finished forms for the trade. In the following table is given the quantity and value of the emery and corundum produced in the United States since 1881, all figures since 1906 relating to emery:

Annual production of corundum and emery, 1881–1910, 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	1910	1,028	15,077

NEW YORK DEPOSITS OF EMERY.

The deposits of emery near Peekskill, Westchester County, N. Y., are located about 4 miles southeast of the town and a few miles east of Hudson River. They were first exploited for iron ore, but the material proved to be too refractory for use in the blast furnace, and its exploitation for iron had to be abandoned. The emery occurs in a series of igneous rocks intruded into metamorphic sedimentary rocks. To these intrusions the name "Cortlandt series" has been applied. They include rocks belonging mainly to the norite, diorite, and peridotite classes. The emery deposits, according to G. H. Williams,[1] are simply segregations of the basic oxides in the norite, the components of the latter rock occurring in even the purest emery ore. A study of thin sections of material from these deposits has revealed the presence of hercynite (iron spinel), magnetite, garnet, and corundum, some of the corundum being pale blue and perfectly transparent. Of these minerals, H. C. Magnus [2] states that in some cases hercynite forms nearly 100 per cent of the material, and in others corundum makes up more than 50 per cent of it. Hercynite is inferior in hardness to corundum, being 8 in the scale of hardness, while corundum is 9. This softness, however, is in part compensated by a readier cleavage, which causes hercynite to present fresh, sharp cutting edges.

The deposits of emery vary considerably in size. They are all worked by open cuts, which vary in width and depth with the size of the ore body. The ore is blasted out by light charges of explosives and is broken up and roughly cobbed before shipment to the mill. The subsequent mill treatment consists in cleansing and grading the rough cobbed material for use in the form of emery powder, emery paper and cloth, and emery wheels. It has been claimed that the Westchester material is very serviceable when made into wheels with a vitreous bond, but, in general, the selection of a bond depends upon the work to be accomplished, and the work to be accomplished should always be stated when ordering the wheel.

IMPORTS.

The following table gives the quantity and value of the emery and corundum imported into the United States from all foreign countries during the last five years. The year 1910 was marked by a notable increase in the importations, particularly of emery, chiefly in that entering under the classification of crude ore and rock. Though the quantity of grain emery was less than that reported in 1909, its value nearly doubled, a condition of affairs which is not easily reconciled. The imports of manufactures of emery were considerably smaller than for the preceding year.

Emery and corundum imported into the United States, 1906–1910.

Year.	Grains.		Ore and rock.		Other manufactures.	Total value.
	Quantity.	Value.	Quantity.	Value.	Value.	
	Pounds.		*Long tons.*			
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
1910	2,321,877	260,124	27,298	540,516	15,527	816,167

[1] Am. Jour. Sci., 3d ser. vol. 33, 1887 p. 33 et seq.
[2] Twenty-third Rept. State Geologist, New York State Mus., 1903, pp. 163–172.

CANADIAN CORUNDUM.

Canadian corundum is obtained principally from pink syenite and nepheline syenite in the Province of Ontario. The output comes chiefly from the Craigmont district, in Renfrew County. There was an increased production of corundum in Canada in 1910. The quantity of ore treated during the year was 37,183 tons, from which there were produced 1,686 tons of grain corundum. The shipments were 106 tons, sold in Canada, and 1,774 tons, sold in other countries, a total of 1,870 tons, valued at $198,680. The following table gives the quantity and value of Canadian corundum shipped during the last five years:

Shipments of Canadian corundum, 1906-1910, in short tons.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
1906	2,274	$204,973	1909	1,491	$162,492
1907	1,892	177,922	1910	1,870	198,680
1908	1,089	100,398			

ABRASIVE GARNET.

The production of abrasive garnet in 1910 amounted to 3,814 short tons, valued at $113,574. This was an increase of 842 tons, or 28 per cent, in quantity and of $11,259, or 11 per cent, in value. The industry is gradually regaining the ground lost as a result of the extreme decline in 1908, and the returns state that business improved in New York, the leading State engaged in the garnet industry. The gain made by this State, so far as output is concerned, was about the same in 1910 as it was in 1909. The industry is practically confined to New York State, but a small production was reported from North Carolina and New Hampshire. In the following table is given the quantity and value of the abrasive garnet produced in the United States from 1895 to 1910, inclusive:

Production of abrasive garnet, 1895-1910, 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	211,680
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	1910	3,814	113,574

NOTES ON THE ABRASIVE GARNET INDUSTRY.

The production of abrasive garnet is a well-established industry in the Adirondack region of New York. The seat of the industry in 1910 was in the northwest part of Warren County, along the line of the Delaware & Hudson R. R. Co., in the valley of the upper Hudson River. The latest and best account of the garnet industry in New

York is by D. H. Newland.[1] According to Newland, the garnet that comes from the Adirondack region has, in the better grades, a deep red color. The rock in which it is found is a plagioclase-hornblende-feldspar aggregate, which has been metamorphosed, and in which the garnet has probably resulted from recrystallization. The garnet crystals vary in size from 5 or 6 inches to more than a foot in diameter, and a single crystal has been known to yield more than a ton of abrasive material. The garnet is more or less shattered, a condition which makes hand picking easy, the method practiced by most of the companies. When the large crystals are broken, they crumble under slight pressure, and may then be readily removed from the matrix. The fragments generally display smooth surfaces on one or more sides, due to a well-developed parting, a feature which adds to the efficiency of the garnet as an abrasive. The fractured condition has resulted probably from regional compression, evidences of which are seen in the crushing and faulting of the country rock.

The capacity of the mines in Warren County is greater than the average output, and the production could be raised much beyond what it was in 1910 without taxing the present facilities. One of the companies, the North River Garnet Co., is equipped to work throughout the year, and is moreover the only company employing mechanical methods for recovering the garnet. The mines and mills of the company are situated on the slope of a mountain on the shore of Thirteenth Lake. The whole western face of the mountain consists of garnet rock, the supply of which is practically inexhaustible. The rock is crushed and then run through special types of jigs. Close work is required of these in order to effect a separation of the garnet and the hornblende, which differ but slightly in their specific gravity. The garnet concentrates, however, are brought up to a high degree of purity. The manufacture of abrasive garnet in this country is limited to a few companies, and there is very little demand for the mineral for export. The mining field, therefore, can not offer encouragement to new developments as long as present production remains so largely in excess of the market requirements.

In the last two or three years a small quantity of Spanish garnet has been imported into the United States for manufacture. This garnet is said to be obtained from river sands. It is cheaper than the domestic garnet, but on account of its uniformly small size is useful only in a minor way.

INFUSORIAL EARTH AND TRIPOLI.

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 as an abrasive, 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

[1] The mining and quarrying industry of New York State: Bull. New York State Mus. No. 142, 1910, pp. 34–37.

the production of rough tripoli blocks worked up into filter stones. Even if this output had been ascertained, 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 1910 infusorial earth and tripoli were produced in the following States, named in order of value of output: Missouri, Illinois, California, New York, Maryland, Connecticut, Virginia, and Massachusetts.

The industry, particularly the tripoli branch, is in a flourishing condition, and the results for 1910 are the highest yet recorded by the Survey.

In the following table is given the production of infusorial earth and tripoli in the United States from 1880 to 1910, inclusive:

Production of infusorial earth and tripoli, 1880–1910, in short tons.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
1880	1,833	$45,660	1896	3,846	$26,792
1881	1,000	10,000	1897	3,833	22,835
1882	1,000	8,000	1898	2,733	16,691
1883	1,000	5,000	1899	4,334	37,032
1884	1,000	5,000	1900	3,615	24,207
1885	1,000	5,000	1901	4,020	52,950
1886	1,200	6,000	1902	5,665	53,244
1887	3,000	15,000	1903	9,219	76,273
1888	1,500	7,500	1904	6,274	44,164
1889	3,466	23,372	1905	10,977	64,037
1890	2,532	50,240	1906	8,099	72,108
1891		21,988	1907		104,406
1892		43,655	1908		97,442
1893		22,582	1909		122,348
1894	2,584	11,718	1910		130,006
1895	4,954	20,514			

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 as an abrasive 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 this quality, in connection with its lightness, has extended its use as a packing material for safes, steam pipes, and boilers, and as a fireproof building material. So far as known it is not used in the manufacture of dynamite in the United States. In this country a new use of the material is reported in the manufacture of records for talking machines. For this purpose it is boiled with shellac, and the resulting product has the necessary hardness to give good results.

In Europe, especially in Germany, infusorial earth 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, 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 the absorptive power of the material 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 vicinity of Soos,[1] a village at the foot of the Erzgebirge, infusorial earth is found in small quantities in the mud of the bogs owned by the city of Carlsbad. It is not of any commercial value, owing to the fact that it is very limited in amount and is shipped only in small samples to collectors of minerals, schools, etc. At Franzensbad infusorial earth underlies the extensive bogs owned by the city. It is obtainable in almost unlimited quantity. No price is quoted by the municipality, and the quality has not been determined by analysis. The infusorial earth is white, yellowish, or gray, and exists here in chalklike form. It is molded, burned, or otherwise treated for the manufacture of pottery and statuary, gold edges, papier-mâché, dynamite, putty, and as adulterant for soap, caoutchouc, and carbolic-acid preparations. A nonconductor of heat and electricity, it is employed as a filling in the walls of ice chests and ice houses and for insulation. Infusorial earth is also used for water purification in the Bergfeld filters.

IMPORTS.

The imports of infusorial earth and tripoli into the United States are not separately recorded by the Department of Commerce and Labor but are included with rottenstone used for similar purposes. The value of the imports of rottenstone and of tripoli for the last five years has been as follows: 1906, $25,990; 1907, $27,121; 1908, $17,252; 1909, $24,024; and 1910, $116,057. No record is kept of the number of tons of this material imported.

PUMICE.

PRODUCTION.

The pumice produced in the United States in 1910 amounted to 23,271 short tons, valued at $94,943, an increase of 8,168 tons in quantity and of $61,504 in value. The large increase in value is noteworthy, the value per ton reported being 85 per cent greater than that for 1909. The pumice reported in this chapter is used as an abrasive, but some pumice is known to have been used already as a building

[1] Daily Cons. and Trade Rept., Jan. 17, 1911, p. 198.

stone. The pumice comes chiefly from a group of four counties along the border between Kansas and Nebraska. These are Phillips and Norton counties, Kans., and of more importance, Furnas and Harlan counties, Nebr. Lincoln County, Nebr., also produced considerable pumice during the year. The business is reported good and the returns show a more prosperous condition in the industry than ever reported previously by the Geological Survey. The production in the United States during the last five years is given in the following table:

Production of pumice in the United States, 1906–1910, in short tons.

Year.	Quantity.	Value.	Price per ton.
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
1910	23,271	94,943	4.08

IMPORTS.

The imports of pumice into the United States in 1910 were valued at $104,425, an increase of $3,428 over 1909. 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, 1906–1910.

1906	$111,695
1907	85,647
1908	67,094
1909	100,997
1910	104,425

ARTIFICIAL ABRASIVES.

PRODUCTION.

In the class of artificial abrasives are included carborundum, alundum, and crushed steel. "Aloxite" and "samite" are trade names applied to forms of carborundum recently placed on the domestic market, notices of which appeared in this chapter for 1909. Carborundum was first mentioned in the report on abrasives in 1897 and crushed steel for the first time in 1899. Alundum was mentioned first in 1901 under the name of artificial corundum. These industries have grown vigorously since the time they were first started and their value in 1910 exceeded that of the natural abrasives by $197,225. The production of artificial abrasives in 1910 showed an increase of 2,559,000 pounds in quantity and of $238,210 in value, as compared with 1909, the percentages of increase being 13 and 17, respectively.

A new artificial abrasive, "corubin," manufactured abroad, has recently been put upon the market. The Goldschmidt Thermit Co., 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 oxides. 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 carborundum, crushed steel, and alundum in the United States since 1906, inclusive, is given in the following table:

Production of artificial abrasives in the United States, 1906–1910, in pounds.

Year.	Quantity.	Value.
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
1910	23,027,000	1,604,030

ALUNDUM.

The artificial abrasive known as "alundum" is made in the electric furnace from the mineral bauxite. During the process the bauxite is purified so that the product is high in crystalline aluminum oxide. The quality of the product is under control, and since the raw material from which it is made occurs in large quantities, the quantity of alundum which may be turned out at the present time is limited only by the demand for it. It can be duplicated in quality, since, as before stated, its quality is under control.

In a recent article on modern abrasives, by George N. Jeppson,[1] an analysis of alundum is given as follows:

Analysis of alundum.

Aluminum oxide (Al_2O_3)	91.25
Ferric oxide (Fe_2O_3)	2.50
Silica (SiO_2)	1.75
Titanium oxide (TiO_2)	4.35
Calcium oxide (CaO)	.25
Magnetic iron (Fe_3O_4)	1.25
	101.35

In the preparation of the bauxite for the electric furnace it has been the custom to calcine it in order to expel as much of its water as possible and thereafter to fuse the material in the furnace with a small amount of carbon. The product is massive, varies in color according to the amount and character of the impurities present, which, as will be seen from the above analysis, are chiefly silica, together with oxides of iron, titanium, and calcium, which constitute anywhere from 10 to 25 per cent by weight of the product. The above-mentioned impurities, even when present in comparatively small amounts, modify the physical characteristics of the product and its properties as related to certain industrial uses. In a recent process patented by George N. Jeppson and Lewis E. Saunders (No. 954808), dated April 12, 1910, these impurities are eliminated and a product formed possessing a temper, which not only makes it last longer under conditions of use, but makes it applicable to uses in the form of grinding wheels, to which commercial forms of alundum do

[1] The Metal Industry, vol. 9, No. 4, April, 1911, p. 156.

not seem to be so well adapted. In preparing the alundum the patentees proceed as follows:

Alumina substantially free from oxides of iron, silicon, or titanium, is melted in an electric furnace between graphite electrodes, the charge being fed more rapidly than is the practice with impure alumina. It results from this relatively rapid feeding and from the use of graphite electrodes, as distinguished from ordinary carbon that the product undergoes but little reduction, possesses an essentially crystalline structure, and is not contaminated with large amounts of aluminum carbid, the effect of which is to cause the mass to disintegrate on long exposure. The more rapid the feeding, the more pronounced are those characteristics of temper which impart to the material its distinctive qualities as an abrasive. The resulting pig or mass, usually nearly or quite white in color and possessing a very marked crystalline structure, is broken up, crushed, and preferably subjected to an oxidizing roast to remove traces of carbid and to improve its bonding qualities. The particles are then graded and molded into the desired articles or implements by means of an appropriate bond, preferably a ceramic bond.

Various bonds may be used, a bond suitable for the purpose comprising a mixture of one part of ball clay with one part of feldspar, 4 ounces of this mixture being used for each pound of abrasive grains. Wheels so bonded possess the above-described characteristic that under conditions of use the abrasive grains fracture in the bond, thus always presenting fresh and keen-cutting points and edges to the work. In this respect the wheel differs radically from those heretofore prepared from impure or partially purified bauxite or other commercial forms of alumina, the grains of which become dulled and glazed, and then break out from the bond without fracturing to any important extent, the bond being carefully prepared to admit of this effect without which the efficiency of the wheel would be greatly diminished, the work would be burned, and the wheel would require frequent renewal of its cutting face by dressing.

It is impracticable to specify any fixed percentage of impurities which renders the product unsuited for the purposes above mentioned, as for the specific purpose of internal grinding, as this depends upon the quality or chemical nature of the impurities. In general it may be stated, however, that the total impurities in the product should not exceed 5 per cent, that the percentage of oxids of silica and titanium should not exceed 1 per cent each, and the percentage of iron oxid should preferably not exceed one-half per cent. For purposes of illustration an analysis is given below of a product having those qualities of temper which adapt it in a very high degree for the specific purpose of internal grinding:

Analysis of alumina for internal grinding.

Al_2O_3	99.64
TiO_2	None.
SiO_2	.20
Fe_2O_3	.16
CaO	None.
	100.00

For comparison with the above the following is an analysis of an exceptionally high grade of electric furnace alumina as heretofore prepared from the best quality of commercial bauxite which has undergone partial purification during the electric-furnace fusion, the same exhibiting a degree of toughness and a massive character which, while imparting to it a high value as an abrasive or refractory for general purposes, renders it unsuited for the specific purpose of internal grinding:

Analysis of high-grade electric-furnace alumina.

Al_2O_3	92.32
TiO_2	3.04
SiO_2	1.12
Fe_2O_3	1.77
CaO	1.75
	100.00

ARSENIC.

By Frank L. Hess.

As in the two preceding years, 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. A new arsenic saving plant began operations during 1910, that of the Globe smelter at Denver, Colo. Each of the three arsenic plants which operated in 1909 also made a production during 1910.

The arsenic mines at Brinton, Floyd County, Va., and at Mineral, Wash., did not operate, owing to the low price of white arsenic.

The production and importation of white arsenic, arsenic, and arsenic sulphides and of Paris green and London purple since 1901 are given in the following table:

Production and imports of arsenic, 1901–1910.

Years.	Production of white arsenic.		Imports.[b]			
			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
1910	1,497	52,305	5,139	314,306	181,363	14,648

a There were only two producers of arsenic in the United States in 1908, so that the figures of production may not be given.
b Figures furnished by the Bureau of Statistics.

The white arsenic imported amounted to 1,348 short tons, valued at $76,282, and sulphide of arsenic was imported to the quantity of 3,791 tons, valued at $238,024.

The value given for the imported white arsenic seems high when compared with the price of the domestic product, which averaged about $1\frac{3}{4}$ cents per pound. However, the technical journals quoted arsenic at New York at from $2\frac{1}{4}$ to $3\frac{1}{4}$ cents per pound, the higher price at the beginning of the year and the lower price at the close.

At the beginning of the year Paris green was quoted by the Oil, Paint, and Drug Reporter at 17 cents per pound in bulk in arsenic kegs; at $17\frac{1}{2}$ cents per pound in 100-pound and 175-pound kegs; at $18\frac{1}{2}$ cents per pound in 14-pound, 28-pound, and 56-pound kits; at 19 cents per pound in 2-pound and 5-pound packages; at 20 cents per pound in 1-pound packages; at 21 cents per pound in $\frac{1}{2}$-pound packages, and at 22 cents per pound in $\frac{1}{4}$-pound packages. The first of May these prices fell 2 cents per pound. Lead arsenate sold for from $8\frac{1}{4}$ cents to 15 cents per pound and realgar from $6\frac{1}{4}$ to 8 cents per pound.

BORAX.

By Charles G. Yale.

PRODUCTION.

In 1910 the production of borax in the United States was 42,357 tons, valued at $1,201,842, as compared with 41,434 tons in 1909, valued at $1,534,365. The quantity stated is the crude material mined, and the value is fixed in accordance with the percentage of anhydrous boric acid in the ore. The reason that the value was less in 1910 than in 1909, notwithstanding that the quantity mined was larger in 1910, is that the ore shipped carried fewer units of anhydrous boric acid than that mined in 1909. 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 entire product of borax in the United States continues to be derived from the State of California.

The statistics of production of borax in California from 1895 to 1910, inclusive, are given in the following table, the values for the years 1895 to 1910, inclusive, being based on the boric-acid content of the tonnage of crude borate of lime, or colemanite:

Production of borax in California, 1895–1910.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
	Short tons.			*Short tons.*	
1895	5,959	$595,900	1903	34,430	$661,400
1896	6,754	675,400	1904	45,647	698,810
1897	8,000	1,108,000	1905	46,334	1,019,154
1898	8,000	1,120,000	1906	58,173	1,182,410
1899	20,357	1,139,882	1907	52,850	1,121,520
1900	25,837	1,013,251	1908	25,000	975,000
1901	23,231	1,012,118	1909	41,434	1,534,365
1902	20,004	2,538,614	1910	42,357	1,201,842

IMPORTS.

The following table shows the imports of borax and borates into the United States from 1902 to 1910, inclusive:

Imports of borax and borates into the United States, 1902–1910, 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
1910	6,860	1,170	563	60	336,466	11,167

BORAX INDUSTRY IN 1910.

In view of the fact that virtually the entire product of borax in the United States continues to be derived from two mines in California, one in Inyo County and the other in Los Angeles County, it is impracticable to give much of a review of the mining conditions. In fact there is little to record, there having been no changes of moment during the year 1910. The ore now handled is all colemanite. 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. Many 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.

FLUORSPAR AND CRYOLITE.

By Ernest F. Burchard.

FLUORSPAR.

INTRODUCTION.

Character.—Fluorspar or fluorite, chemically calcium fluoride (CaF_2), consists of calcium and fluorine in the proportions of 51.1 to 48.9. The mineral is crystalline, only slightly harder than calcite. It crystallizes in the isometric system and is found commonly in cubical crystals. In color the spar ranges, according to purity, from a clear, slightly bluish or green, glasslike substance through various other brilliant colors to dark purple, although much of it is white and opaque. Fluorspar, associated with other minerals, has a broad distribution geographically and a wide range geologically. The deposits thus far exploited in the United States are, however, confined to the Territories and States of Arizona, New Mexico, Colorado, Illinois, Kentucky, Tennessee, and New Hampshire.

Commercial value.—Fluorspar is a mineral of relatively low value as compared with metallic ores mined under similar conditions. Under the most favorable conditions, therefore, the margin of profit can never be expected to be large, and it requires exceptionally good management to conduct any spar mining operations profitably, especially in the Western States. In 1910 there were 69,427 short tons of domestic fluorspar, including gravel, lump, and ground varieties, marketed in the United States at an average value of about $6.20 per short ton. Of this total, 61,136 short tons were sold as gravel and lump spar, at an average value of $5.58 per ton at the mines, and 8,291 short tons were sold ground, at an average value of $10.72 per ton f. o. b. cars.

Uses and requirements of fluorspar.—Fluorspar is used in the manufacture of glass and of enameled and sanitary ware, in the electrolytic refining of antimony and lead, the production of aluminum, the manufacture of hydrofluoric acid, and in the iron and steel industries, in which it is used as a flux in blast furnaces and in basic open-hearth steel furnaces. It is estimated that about 80 per cent of the American fluorspar output, mainly in the form of gravel spar, is consumed in the manufacture of basic open-hearth steel. The use of fluorspar is increasing in practically all of these industries. The western market for fluorspar is more limited than that of the Central and Eastern States, but it is nevertheless increasing. Recently the iron and steel works at Irondale, Wash., and in Shasta County, Cal., have been enlarged.

Supplies of spar mined in the West have heretofore not been sufficient to supply the western market for more than a few months at a time. This has been due to several conditions, the most important of which is that most of the western spar thus far produced has not been of as high a grade as that produced in the Illinois-Kentucky district. Fluorspar for iron and steel making should carry at least 85 per cent calcium fluoride and preferably it should be purer. For most other chemical uses it should contain from 95 per cent to 98 per cent calcium fluoride.

PRODUCTION.

The total quantity of domestic fluorspar reported to the Survey as marketed in the United States in 1910 was 69,427 short tons, valued at $430,196, as compared with 50,742 short tons, valued at $291,747, in 1909, an increase in quantity of 18,685 short tons and in value of $138,449. This increase represented nearly 37 per cent of the quantity and 47 per cent of the value of the production of 1909. The production in 1910 was the largest ever recorded. The average value per ton for the whole country, considering all grades of fluorspar, was about $6.20 in 1910 as compared with $5.75 in 1909. This value represents the selling price on board cars at railroad or water shipping points, and with reference to the product from Colorado, New Mexico, and Kentucky the price reported for much of the spar includes the cost of a long wagon haul—$1.50 to $3 a ton. In Illinois the principal producing mines are near river transportation, and the cost of long wagon hauls has not entered into the reported value of the fluorspar.

Fluorspar was produced in 1910 in Illinois, Kentucky, New Mexico, and Colorado in the order named, each State, except Colorado, reporting an increased production. The product of Colorado and New Mexico has been classed as gravel spar, although much of the New Mexico product was equal to the grade of lump spar. Both Illinois and Kentucky produced gravel, lump, and ground spar.

The following table gives the quantity and value of the different grades of fluorspar marketed in the United States, by States, in 1909 and 1910:

Fluorspar marketed in 1909 and 1910, in short tons.

States.	Gravel.		Lump.		Ground.		Total quantity.	Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.		
1909.								
Colorado	[a] 1,090	$6,263	....	....	....	....	[a] 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
1910.								
Colorado	[b] 5,122	27,858	....	....	....	....	[b] 5,122	27,858
Illinois	35,477	178,880	6,151	38,415	5,674	60,469	47,302	277,764
Kentucky	11,414	75,823	2,972	20,359	2,617	28,392	17,003	124,574
Total	52,013	282,561	9,123	58,774	8,291	88,861	69,427	430,196

[a] Includes a small production of gravel spar from New Mexico and of lump spar from Arizona.
[b] Includes New Mexico.

The annual production of fluorspar in the United States since 1883 is given in the following table:

Production of fluorspar in the United States, 1883–1910, 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	1910	69,427	430,196

In 1910 Illinois produced a total of 47,302 short tons of spar, valued at $277,764, or $5.87 per short ton on board cars. The gravel spar amounted to 35,477 short tons, valued at $178,880, or $5.04 per ton. The sales of lump spar in Illinois were 6,151 short tons, valued at $38,415, or $6.25 per ton. The ground spar sold in this State amounted to 5,674 short tons, valued at $60,469, or $10.66 per ton. Kentucky reported total sales of 17,003 short tons of spar, valued at $124,574, or an average price of $7.33 per ton, distributed as follows: Eleven thousand four hundred and fourteen short tons of gravel spar, valued at $75,823, or $6.64 per ton; 2,972 short tons of lump spar, valued at $20,359, or $6.85 per ton; and 2,617 short tons of ground spar, valued at $28,392, or $10.85 per ton. Colorado and New Mexico together produced 5,122 tons of gravel spar, valued at $27,858, or $5.44 per ton. The total stocks of fluorspar reported on hand in all the States December 31, 1910, were less than 2,000 tons.

TRADE CONDITIONS.

The demand for American fluorspar at Pittsburg, Birmingham, and other cities during 1910 was apparently greater than the capacity of the mills operating in the Illinois-Kentucky district. Prices advanced a little, but not enough to pay many of the smaller companies for operating, and consequently many of them were idle in both States. As a consequence of the increased demand, large stocks left over from previous years were practically cleaned up in localities within reach of transportation lines. Many steel plants purchased reserve stocks in anticipation of possible future scarcity of fluorspar. The steel plant at Pueblo, Colo., took the whole output of the Colorado and New Mexico producers in 1910, besides some spar from Illinois, but did not consume the total quantity purchased. Although, as noted on another page, the imports were exceedingly high, notwithstanding the import duty of $3 per ton imposed in 1909, the market for domestic spar does not appear to have been seriously affected by the quantities of fluorspar imported.

The conditions in the open-hearth steel industry have a most direct bearing on the production of fluorspar, since the greater part of the gravel spar produced is used in the manufacture of basic open-hearth steel. The increase in the quantity of basic open-hearth steel in 1910, as compared with 1909, amounted to 1,874,857 long tons, or nearly 14 per cent. The following table[1] shows the production of open-hearth steel during the last three years:

Production of open-hearth steel in 1908–1910, in long tons.

	Basic.	Acid.	Total.
1908	7,140,425	696,304	7,836,729
1909	13,417,472	1,076,464	14,493,936
1910	15,292,329	1,212,180	16,504,509

IMPORTS.

Before August, 1909, fluorspar was imported into the United States duty free, and the full statistics of importation were not given before that date. 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 competed with American fluorspar as far west as Pittsburg and practically fixed the market price at that point. In the Lehigh and Susquehanna valleys of Pennsylvania and other localities near the Atlantic seaboard English fluorspar can yet be purchased advantageously under present conditions, and large quantities are consumed annually in the open-hearth steel furnaces. The imports of fluorspar entered for consumption into the United States in 1910 were 42,488 short tons, valued at $135,152, as compared with 6,971 short tons, valued at $26,377, in 1909. The value assigned to the material in 1910 was $3.18 per ton, as compared with $3.78 in 1909.

MINING AND MILLING DEVELOPMENTS.

ILLINOIS.

The principal developments during 1910 were confined to the properties of the Fairview Fluorspar & Lead Co., at Fairview Landing, and the Rosiclare Lead and Fluorspar mines, at Rosiclare. At other properties there was some prospecting by drill and a little mining, but the greater part of the output came from the two companies named.

At the Fairview mine four shafts produced ore, including one mining the "blue" vein. The deepest shaft (or steep incline) was reported 503 feet deep in the spring of 1911 and the deepest working level was 475 feet below the surface. At this level considerable calcite is encountered, either mixed with spar or else constituting nearly the whole vein. The vein is irregular in width, ranging from pinches 18 inches wide to swellings 25 feet wide. The spar bodies exhibit irregular outlines within the vein, and range from a few feet to 22

[1] Ann. Statist. Rept. Am. Iron and Steel Association, Philadelphia, Pa., July 25, 1911.

feet in width. One of the largest bodies was encountered at the 400-foot level. A new shaft has recently been sunk to a depth of about 320 feet, with levels at 100 feet, 235 feet, and 295 feet from the surface. The "blue" vein shaft was at that time reported to be down 120 feet and to show 4½ feet of ore at the bottom. An important production was stoped from this vein in 1910. The main workings of the Fairview and the Rosiclare companies are approaching one another and are believed to be on the same vein. The mill at Fairview has recently been improved and enlarged, particularly with reference to the facilities for the preliminary picking and the final jigging of the spar. The jigs are reported to consist of a 5-cell rougher, a 6-cell cleaner, and a 5-cell finisher. The capacity of the mill is reported at 200 to 250 tons of cleaned spar per 10-hour shift and the storage capacity at about 3,000 tons. Spar is loaded directly at the mill into standard-gage cars, which are moved over a short line to the landing on Ohio River and towed on barges to the Illinois Central Railroad at Golconda.

At Rosiclare the mining method has been changed from underhand to overhead stoping. Only one shaft is operated here, and the lowest level was 235 feet below the surface in April, 1911. In July it was reported that the shaft had been sunk to 275 feet and was planned to be sunk to a depth of about 335 feet, where a new level will be established. Local pinching and swelling is characteristic of the vein, the width ranging from a few inches to 22 feet. In places the vein is found to carry almost entirely calcite, but there are large quantities of good ore still available above the lowest level, in both directions from the shaft. A new steel and concrete mill, entirely fireproof, has been built at Rosiclare, designed to reduce 500 tons of crude ore per day. The shaft has been reconstructed and consists of three compartments, two of which, for hoisting, are 5 feet 5 inches by 4 feet 4 inches, and one is a pump compartment, 5 feet 5 inches by 3 feet 8 inches. The mill consists of three large buildings. The sizing and sorting building, with the shaft at the south end, stands in the middle, with the power house and grinding building to the west and the concentrating building, or jig house, to the east. All the buildings are approximately 90 feet long. The middle building is 20 feet wide at the base, and the head frame stands 84 feet high. The two other buildings are 36 feet wide and stand 30 feet to the eaves. The alleys between the middle building and the two other buildings are 14 feet 6 inches wide.

From the mine the spar is hoisted to the top of the mill in steel cars having a capacity of one ton each. The spar is dumped on steel grizzlies having 2½-inch spaces. The grizzlies are inclined toward two 24-inch steel apron conveyers. From the oversize No. 1 lump spar is picked and thrown on the conveyers. The common spar not passing the grizzly is shoveled into a No. 5 gyratory crusher. The total capacity of the grizzlies is about 100 tons of material. The material passing the grizzly and the crusher feeds down into two 150-ton steel bins on the floor below. These bins feed into two shaking screens on the floor next below. These screens have steel frames 17 feet by 2 feet 9 inches, with bottoms of heavy wire with meshes about ½ inch by 1⅛ inches. The lump spar is delivered by the apron conveyer to a rotary drier 25 feet long by 36 inches in diameter, which is supplied with hot air from the top of the boilers. The ore falls from the drier on a "butterfly," which diverts the material as desired, either into a bin for No. 2 lump spar or through a drying tower into a No. 3 crusher. The No. 2 lump spar may be drawn directly from the bin, barreled, and shipped. The No. 1 spar passes through the No. 3 crusher, which feeds by gravity into a grinding mill. This mill discharges through a 30-mesh, 30-wire screen into a screw conveyer, which moves the ground spar to four storage bins. Each bin feeds into a barrel which stands on a packer. The barrels of ground spar weigh 550 to 610 pounds when filled. The capacity of this packing room is about 10 barrels per hour, or 30 tons a day.

From the shaking screens the undersize is carried by water through a 9-inch pipe to the jig house, and the oversize of the screens falls on a picking belt, on which 9 to 15 men may work. On this belt separation is made by hand of the larger fragments of lead and zinc ore, calcite, waste, and fluorspar. Lump spar can thus be picked, if desired, in order to increase the quantity secured by picking on the grizzly above. The waste and calcite are thrown directly to chutes leading to their respective bins, while the lead and zinc ores pass through short chutes to separate troughs just below the picking belt, and are moved by a double shaking conveyer to separate 13-inch disk crushers. The overrun of fluorspar from the picking belt passes in the opposite direction to a 24-inch disk crusher. The lead and zinc ores discharged from their respective disk crushers are carried through pipes across to pulsator jigs in the jig house. From the 24-inch disk crusher the spar and the fine lead and zinc ores are fed into a bin. This bin feeds into the same service pipe which receives the undersize from the shaking screens. This service pipe crosses to the jig house and feeds into a 5-celled rougher jig. The ore from the rougher jig goes to a cleaner jig having six cells. Provision is made for catching the lead from the rougher jig and for taking care of the tailings. Between the rougher jig and the cleaner jig are sand crushers and several pumps, and the system is very flexible. The lead and zinc ores coming from the 13-inch disk crushers are treated by two 4-celled pulsator jigs, having a set of laboratory rolls. Of the ore at present considered normal about 90 per cent consists of concentrates of fluorspar, galena, and sphalerite (zinc blende). The galena recovered constitutes about 1 per cent of the concentrates, and the sphalerite still less. It is planned to treat a large quantity of tailings from the old mill, of greater richness than those now produced, as soon as the new mill is working perfectly. The milling of fluorspar offers rather difficult problems, for unlike most ores, the bulk of the product must be saved, and the waste which must be eliminated constitutes relatively a small percentage. In addition, the separation of the lead and the zinc from the fluorspar is difficult, particularly where such small percentages of the former minerals are present, yet it is essential that they be almost completely removed, since the presence of sulphide ores renders the fluorspar of little value as a flux in steel making. Moreover, if the separation can be completely and economically effected, the lead and zinc ores recovered materially assist in paying the expense of cleaning the ore.

Under normal conditions about 57 men are employed overhead, including office force and superintendents, and about 48 men underground. When visited in April, 1911, this mill had not been entirely completed, and its capacity had not been demonstrated. It was expected, however, that its capacity would far exceed any other mill built to treat fluorspar and associated ores. The product of this mill is carried to Ohio River over an electric tramway 3,300 feet long, and is then loaded on barges and towed to Shawneetown, Ill., Evansville, Ind., or Golconda, Ill. The river is generally closed by ice for a short period in winter, and in very dry summers the water may become too low for transportation. For this reason an endeavor is made to maintain sufficient stocks of spar from the Rosiclare mines at the railroad in Shawneetown to provide for shortages caused by interrupted shipments.

NEW MEXICO.[1]

Only recently has fluorspar been found in New Mexico in sufficient quantities for exploitation. The American Fireman's Mining Co., of Kansas City, Mo., in prospecting for metallic ores on property situated 10 miles northeast of Deming, Luna County, N. Mex., has opened a number of veins of fluorspar which give promise of containing nearly if not quite sufficient spar to supply the western market for several years.

Location.—The fluorite occurs on the flanks of a small ridge called "Fluorite Ridge," one of the foothills of Cooks Range, 10 miles northeast of Deming. The most promising prospects have been made in two localities separated by a distance of about 1¼ miles. One of the localities is at the extreme southeastern base of the ridge on a gentle rise about 400 feet above the plain; the other well up the south slope of the ridge about 900 feet above the plain. Deming lies in a nearly flat valley covered by desert deposits, with Cooks Range 10 to 15 miles northeast and the Florida Mountains 10 miles or more southeast. The fluorspar deposits are most easily reached by a 10-mile drive from Deming, but the product is shipped from a siding, on the Atchison, Topeka & Santa Fe Railway, called Mirage, 5½ miles southeast of the prospects.

Geologic relations.—Fluorite Ridge consists of a central mass of monzonite porphyry which has intruded strata of Paleozoic and Mesozoic age, chiefly Ordovician limestone and Carboniferous and Cretaceous sandstone, quartzite, and conglomerate. The dips of the sedimentary strata on the south and west sides where the fluorspar is found are very steep, or vertical, and masses of the strata have not only been tilted up by the intrusive action, but folded into the intrusive rock. The base of the ridge is surrounded by an agglomerate consisting of angular masses of andesite embedded in tuff. Some thin dikes of basalt cut the agglomerate, and unconsolidated "desert fill" overlies it at a short distance from the base of the ridge.

Occurrence and character of the fluorspar.—The fluorspar occurs in veins, cutting altered monzonite porphyry. Certain of the veins fill fractures in the rock along which there has been movement in both a vertical and a horizontal direction, but between the walls of some fissures there has not been noticeable displacement. The rock at the southeast base of the ridge is cut by two or more groups of approximately parallel veins. As shown by the openings that have been made,

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[1] A more detailed paper on the New Mexico deposits has recently been published in Bulletin 470-K, U. S. Geol. Survey, 1911, pp. 31-43.

there appear to be at least five or six distinct veins in each group. One group of veins strikes N. 17° E. to N. 27° E., and the other strikes N. 6° E. to N. 18° W., and still other veins were observed to strike at various angles between these limits. The veins are nearly vertical or dip steeply in a southeast or northeast direction. The vein material is mainly fluorite mixed with a little quartz. Where the veins are partly siliceous they resist weathering slightly better than the surrounding porphyry, and therefore leave broken traces on the surface. At the surface the fluorspar in places is altered to calcium carbonate. The thickness of the veins as shown by surface cuts and by prospect pits and shafts ranges from a few inches up to 12 feet or more, but it is generally from 2 to 5 feet. The structure of the veins is in places distinctly banded; in other places the vein appears to consist mainly of a mass of crystalline spar, showing no banding, but carrying pockets of quartz. Brecciation of the vein by which large fragments of the wall rock have been included is not uncommon. The walls of the veins where open to any considerable depth are found to be smooth in places, but they are rarely smooth or regular for many feet, and the wall rock is generally much decomposed.

At the locality on the south slope of the ridge only one set of veins, striking in a northwesterly direction, was observed. They stand nearly vertical or dip steeply toward the northeast. These veins had been opened in only two or three places in 1910, and the maximum width observed was only about 4 feet, not all of which was filled by spar. The veins cut monzonite porphyry, as at the first locality, and were observed to outcrop at intervals in the direction of strike for a distance of one-quarter mile.

Developments.—At locality No. 1 the American Fireman's Mining Co. opened in 1909 a number of veins by means of shallow cuts, and sank several test pits to depths of 6 to 12 feet and two shafts to depths of about 80 feet. In all, about 20 openings had been made up to August, 1910. A triangular area about one-fourth mile wide at base from northwest to southeast, and about one-third mile from northeast to southwest, has been shown to carry productive veins of fluorspar. The surface of the area slopes gently to the southeast. At the main opening the vein strikes N. 17½° E. to N. 22½° E. and dips 65° to 70° toward the southeast. The vein had been opened to a depth of 75 or 80 feet in August, 1910, and had been worked for a distance of about 100 feet on the strike. The thickness between the walls of the vein measures 4 feet to 12½ feet, the irregularities being due to pinching together of the walls in places. The strike of the vein is apparently slightly sinuous, according to the irregularities in the walls, but there are no evidences of movement between the walls. The rock inclosing the vein is altered to a reddish color so far as observed, and although the vein walls are smooth and clean in places, in other places there is interpenetration of vein and wall material.

The fluorspar is principally of a light-green shade, but there is some purple spar present, especially near the margins of the vein, and some quartz is present in pockets and thin stringers scattered throughout the mass of spar. The spar is mined from several levels and milled down through chutes to the lowest level, from which it is hoisted in buckets up the shaft to the surface. A steam hoist was being installed in August, 1910. On the strike of the opening, less than 100 yards north of the shaft, an open cut and shallow burrow showed a promising vein of spar with a fork extending in a northwest direction. These veins and one other a few yards to the west are the nearest to the limestone mass, which lies 35 yards or more to the west. So far as could be ascertained, none of the veins extend into the limestone. The greater part of the spar that has been produced in this region has been taken from the shaft just mentioned.

The other veins that have been opened here lie 250 to 325 yards west of and at a lower level than the principal shaft. Eight or ten shallow trenches and one test pit about 30 feet deep have been dug here, exposing veins 6 inches to 4 feet thick containing good fluorspar in places and running into barren or highly siliceous material in others. Some of these veins strike a little west of north, and others strike N. 30° W. to N. 42° W. A considerable showing of spar has been developed by a series of trenches, pits, and a shaft, at a point about one-fourth mile north of the company's store, where there appear to be two or three veins nearly parallel and only a few yards apart. The main vein seems to follow a fault-plane as indicated by openings extending 100 yards or more. At the deepest place the workings are about 75 feet below the surface. The surface cuts are extensive and show the structure fairly well. The footwall of the vein is a cherty conglomerate, resembling the material capping the ridge three-fourths of a mile west. The hanging wall is so covered with spar that it is difficult to determine its nature. Where the spar has been removed the wall is shown to be surfaced by soft clay, so that a thin layer of spar is generally left to prevent caving. The indications at the surface are, however, that the hanging wall is of agglomerate. In places west of the fault, or beyond the footwall, loose fragments of reddish granitic and porphyritic rock were noted on the surface. The fault hades toward the hanging wall, which is on the upthrow side. Just to the north of the shaft the strike of the vein has been so bent that for 3 or 4 feet the fluorspar has been offset and cut out entirely. At this point the walls are much slickensided in a nearly horizontal direction. There is general evidence of faulting here since the vein material was deposited. The outcrop of the vein has been repeated, and a small section of it that had been shoved over to the west 10 feet or more was at first thought by the miners to be another vein, but it was soon discovered that it ceased at shallow depth. The main vein here showed from 1 foot to 7 or 8 feet of good fluorspar. A considerable tonnage has been mined and some shipments have been made.

At these prospects the fluorspar is not subjected to any mechanical concentration but is simply cobbed and stacked up in piles of lump and gravel spar from which shipments are made. The spar is hauled by wagons 5½ miles to Mirage, a station on the Atchison, Topeka & Santa Fe Railway, over a road that is generally down grade for a mile or more, and then nearly flat. At the base of the grade is a platform scale on which all the shipments are weighed. For several miles the road is rather sandy, making the hauling of heavy loads difficult. In 1910 G. M. Sadler, of Deming, succeeded the American Fireman's Mining Co. in the operation of the prospects. A series of analyses are given on a subsequent page, which show the general excellence of the spar that has been mined from this district.

At the second locality mentioned, about 1¼ miles northwest of the locality just described, Mr. Sadler has opened by surface cuts a few veins of fluorspar. The openings are within 200 feet to 250 feet of the summit of the ridge, and are on a rather steep south-facing slope. The principal opening is on a nearly vertical vein that strikes north to northwest, bending toward the west as it is driven farther. In August, 1910, this opening extended about 100 feet and reached a depth of about 15 feet at the extreme end. As opened, the vein ranges in thickness from less than 1 foot to more than 4 feet, but the maximum thickness is not all fluorspar. The spar is streaked with silica and iron oxide, and shows quartz druses and geodes and some reddish-brown quartzitic seams and pockets, but in places there are quite pure masses of apple-green spar. The spar on the dump was a mixture of green and reddish-brown material with a considerable scale of clay and ferruginous material. Another trench several hundred yards toward the east at a slightly lower level has exposed for 200 or more feet a vein showing discontinuous fluorspar 12 inches to 18 inches thick, which is largely altered to calcium carbonate at the surface. The spar below the surface is rather clean looking, but this thickness is hardly sufficient for exploitation, except at very shallow depths.

No spar had been shipped from the second locality up to August, 1910, although preparations were being made to ship some material from the largest cut. A platform upon which spar is wheeled in barrows has been built above the wagon road to facilitate the loading of wagons.

Grades of western fluorspar.—None of the spar that has been mined in Colorado and New Mexico has been cleaned in any way except by hand. Mechanical concentration would improve the grade of the Colorado spar greatly, but none of the fluorspar prospects in Colorado have proved of sufficient richness to warrant the installation of washing plants. In certain places water is available, but in others the problem of finding water would be difficult. The Colorado product has never averaged quite high enough in grade to fully satisfy purchasers or to command a price satisfactory to producers. With regard to the deposits near Deming, N. Mex., there is little necessity for washing the spar on account of the unusual purity of the vein material. Doubtless a considerable saving of spar might be accomplished by washing, but such a process would not be at all feasible on account of the scarcity of water. Supplies of water for men, teams, and hoisting engine have to be hauled from a well more than 4 miles distant on the road to Deming. There is little probability that a well could be obtained by drilling anywhere near the fluorspar deposits on account of the nature and structure of the underlying rocks.

Analyses.—The following table gives analyses of gravel fluorspar from Mirage, N. Mex., generally in carload lots used in basic open-hearth steel furnaces, and analyses of spar from Colorado, Illinois, and Kentucky, made on a similar basis, are given for comparison.

Analyses of fluorspar from New Mexico, Colorado, Kentucky, and Illinois.

Locality.	CaF_2.	SiO_2.	Al_2O_3+ Fe_2O_3.	$CaCO_3$.	$MgCO_3$.	Authority.
Mirage, N. Mex	93.68	4.68	0.74	0.76	Trace	Colorado Fuel & Iron Co.
Do	93.55	4.97	.80	.62	do	Do.
Do	91.98	6.60	1.00	.67	do	Do.
Do	88.80	9.83	1.10	.48	do	Do.
Do	88.30	9.85	1.06	.98	do	Do.
Do	89.52	8.62	.92	.79	do	Do.
Do	91.32	6.60	.74	.74	do	Do.
Do	90.13	7.86	.70	.74	do	Do.
Do	92.19	6.05	.68	.83	do	Do.
Do	90.90	6.96	.86	.86	do	Do.
Do	90.22	7.60	1.04	.68	do	Do.
Do	88.59	9.66	.96	.83	do	Do.
Do	93.99	3.84	1.12	1.12	do	Do.
Do	89.70	8.60	.92	.80	do	Do.
Rosita, Colo	81.55	13.3	5.1			Do.
Do	86.75	9.3	4.2			Do.
Do	82.25	12.6	5.0			Do.
Do	84.3	11.6	n. d.			Do.
Do	60.9	27.0	n. d.			Do.
Jamestown, Colo	76.05	19.8	4.2			Do.
Do	83.76	12.2	4.0			Do.
Do	85.9	10.5	3.75			Do.
Do	79.06	15.24	5.26			Do.
Do	86.75	8.60	4.46			Do.
Marion, Ky	84.25	2.98	1.28	10.28		Do.
Do	87.8	3.10	2.06			Do.
Do	90.02	4.72	1.5			Do.
Do	92.7	2.5	.64			Do.
Do	96.01	1.9	1.88			Do.
Do	94.72	1.22	.98	1.82	0.68	Lackawanna Steel Co.
Do	95.63	1.32	.93	.38	1.22	Do.
Fairview, Ill	88.85	3.4	1.45			Carnegie Steel Co.
Do	87.07	3.12		8.96		Fairview Fluorspar & Lead Co.
Do	86.31	4.30		7.57		Do.
Do	86.60	2.38		10.94		Do.
Do	85.35	8.17		4.50		Do.
Do	83.49	4.0		7.67		Do.
Do	84.80	3.51		8.29		Do.
Do	84.50	3.85		8.27		Do.
Do	85.63	3.82		9.21		Do.
Do	88.67	5.13		4.49		Do.
Do	85.61	6.05		4.22		Do.
Do	85.57	6.76		2.26		Do.
Do	86.10	7.39		2.14		Do.
Do	86.87	4.73		4.44		Do.
Do	98.27	.58		.27		Do.
Do	96.62	1.67		.79		Do.
Do	98.30	.46		.46		Do.
Do	95.38	.47		3.55		Do.

From these analyses it will be seen that the spar shipped from Mirage, N. Mex., is of an exceptionally high grade, considering the fact that it has not been washed and cleaned as has the Illinois-Kentucky product.

Cost of production.—The mining of the fluorspar near Deming is done almost wholly by contract. Mexican labor is employed, and miners earn about $1.50 per day. Mining the spar costs per ton $1.75, plus 25 cents for incidental expenses, and haulage to the railroad costs $1.50, making a total cost of $3.50 per ton dumped into cars. The spar in 1910 was selling at $5.25 per ton on the cars, based on at least 90 per cent calcium fluoride, and the freight from Mirage to Pueblo, paid by the purchasers, was $2 per ton. According to contract a penalty of 20 cents per ton is deducted for each per cent that the spar falls below 90 per cent calcium fluoride, but no premium is paid unless it carries more than 95 per cent calcium fluoride, when each unit brings 20 cents more per ton. The equipment for mining the spar is simple, the largest items of expense being the small steam hoist stationed at the deepest working, and the several teams necessary to haul the output. Small store buildings and machine shops have been built at both places where the spar was being developed. The laborers live in tents, and work can be carried on the year round. From the opening of these deposits in the summer of 1909 to the close of 1910 nearly 5,000 tons of fluorspar had been shipped, averaging 92 per cent calcium fluoride.

Conclusions.—The exploration for and development of fluorspar deposits under present conditions in the Western States can not be said to offer attractive profits; nevertheless the market for fluorspar is growing, and where deposits are found so situated that the freight rates do not hold down the price to a profitless level and the cost of haulage does not further wipe out all chances of gain, the development of such deposits should be encouraged.

CRYOLITE.

CHARACTER.

Cryolite[1] is a double salt of sodium fluoride and aluminum fluoride ($3NaF.AlF_3$). It crystallizes in the monoclinic system and has a hardness but little greater than that of gypsum, namely, 2.5. It is found associated with other minerals such as siderite, sphalerite, galena, chalcopyrite, and quartz. The color of cryolite is generally pure white, but in places smoke-colored pieces are found which contain well-developed crystals of red fluorspar.

SOURCE.

Cryolite has been found in commercial quantities only at Ivigtut, an Eskimo hamlet on the southern coast of Greenland in latitude 61° N. Minerals containing cryolite have been found near Pikes Peak, Colo., but not in paying quantities. The cryolite deposit at Ivigtut is reported to be a solid mass having surface dimensions of about 200 feet by 600 feet, and it has been worked as an open cut to a depth of about 150 feet. The deposit widens with depth, and the depth of the deposit is unknown. It has been suggested that the cryolite is of volcanic origin since large pieces of granite from the surrounding rock mass are occasionally found embedded in the cryolite, but, on the other hand, it is difficult to explain the presence of crystallized siderite which decomposes entirely at a temperature below the fusing point of cryolite (about 900° C.).

USES.

Formerly cryolite was used to produce soda and alum, but other and cheaper sources of these materials have displaced cryolite from this particular field. The more important uses at present for cryolite are in the manufacture of opaque glass for the enameling of iron ware, in the metallurgy of aluminum, and as a flux in the manufacture of white Portland cement.

[1] Halland, Alfred S., Cryolite and its industrial applications: Jour. Ind. and Eng. Chem., February, 1911, pp. 63–66.

PREPARATION.

The cryolite is mined from a deep, open quarry, and the material is broken with a sledge hammer and large quantities of the pure white material are picked out by hand. The cryolite that is associated with other minerals is then conveyed to vibrating screens which sort it into four different sizes, from lumps 3 or 4 inches in diameter down to particles the size of a wheat grain. The lumps larger than a walnut are placed on a circular anvil and cleaned by mechanically driven chisels. The pure pieces are picked out while the impure pieces still containing considerable cryolite are mixed with the small screenings and screened again into two sizes from 14 millimeters down to 1 millimeter, and from 1 millimeter down to the finest dust. These two products are next treated separately, first by a separation depending on specific gravity, and next by a magnetic separation. The gravity separation is effected by means of jigs. Magnetic ore separators were originally devised and are still mostly used for the concentration of low-grade magnetic iron ore. For this purpose a comparatively weak magnetic field is employed, but in the case of cryolite separation a very strong field is necessary. By means of the magnetic separation cryolite and galena are collected together, sphalerite and chalcopyrite are collected into another receptacle, and the siderite, or iron carbonate, is gathered in a third receiver. Magnetite, which is always present to a very small extent, is first removed by passing the mass of mineral through a weak magnetic field. The first product from the jigs yields a pure cryolite; the second product yields a mixture of cryolite with some galena; and the following jigging separates them completely. The cryolite separation herein described is carried on at the Oresund Chemical Works, Copenhagen, Denmark.

The purified cryolite is sold either in lumps or ground to a fine powder in a chaser mill. A careful grinding allows here the separation of a small amount of quartz still present, as the quartz is not ground so easily and can be removed by subsequent sifting. The separated gangue minerals possess some value. The iron spar is sold to steel plants, and the galena and chalcopyrite, which contain traces of silver and gold, go to smelters.

IMPORTS AND PRICES.

Thirty-six long tons of cryolite are reported to have been imported into the United States in 1910, valued at $2,343, as compared with 1,278 long tons, valued at $18,427, in 1909. The average value per ton declared in 1910 was apparently $65.08, as compared with $14.41 in 1909. Cryolite is imported free of duty. Refined cryolite is relatively high priced, selling in carload lots, at 6¼ to 7 cents per pound, or about $140 a ton.

LITERATURE ON FLUORSPAR AND CRYOLITE.

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[1] Out of stock, but usually accessible in libraries of cities, technical schools, and universities, and for sale by the Superintendent of Documents, Government Printing Office, Washington, D. C.

GYPSUM.

By Ernest F. Burchard.

PRODUCTION.

The quantity of gypsum mined in 1910 was 2,379,057 short tons, an increase of 5.6 per cent over the production of 1909, which was 2,252,785 short tons, and an increase of more than 38 per cent over that of 1908, which was 1,721,829 short tons. The gypsum sold without calcining and used principally as land plaster and as an ingredient in Portland cement and in paint showed an increase in quantity, but a loss of about 3 cents per ton in value; but the material calcined for plaster increased in quantity 69,632 short tons and 16 cents per ton in selling price at the mills. The total value of gypsum and gypsum products in 1910 was $6,523,029, as compared with $5,906,738 in 1909, an increase of $616,291, or 10.4 per cent.

Gypsum was produced in 16 States and 2 Territories besides Alaska, and the total number of mills reporting in 1910 was 82, as compared with 79 in 1909. This includes mills that ground land plaster as well as those which calcined wall plaster. The largest quantity produced was reported from New York, Michigan and Iowa occupying second and third place. New York enjoyed the greatest share of the increase in production of gypsum in 1910.

The following table gives the statistical data regarding the gypsum industry in 1909 and 1910, by States:

Production of gypsum in the United States in 1909 and 1910, by States and uses, in short tons.

1909.

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, 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	[a] 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	([b])	([b])	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 Oklahoma.
[b] Included in Kansas.

Production of gypsum in the United States in 1909 and 1910, by States and uses, in short tons—Continued.

1910.

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, Montana, New Mexico, South Dakota, and Wyoming	11	211,080	280	$1,009	17,653	$38,476	121,898	$614,807	$654,292
California	7	45,901	4,960	14,185	17,318	46,090	31,824	181,928	242,203
Colorado	4	45,820	....	....	(a)	(a)	37,062	118,809	118,809
Iowa	6	322,713	6,159	8,312	30,532	38,683	230,932	896,854	943,849
Kansas	7	135,088	b 3,751	7,223	41,859	49,971	75,445	320,028	377,222
Michigan	8	357,174	7,097	9,900	57,469	78,478	240,905	579,823	668,201
Nevada and Oregon	5	103,329	4,410	9,322	(a)	(a)	86,123	443,596	452,918
New York	13	467,339	12,494	25,462	160,666	240,148	248,862	888,367	1,153,977
Ohio and Virginia	4	292,987	10,479	24,071	19,292	37,767	226,516	759,375	821,213
Oklahoma	10	162,788	(c)	(c)	10,924	13,896	116,968	442,191	941,256
Texas	3	188,559	(c)	(c)			135,801	485,169	
Utah	4	46,279	4,185	10,841	d 12,301	15,663	31,333	122,585	149,089
	82	2,379,057	53,815	110,325	368,014	559,172	1,583,669	5,853,532	6,523,029

a Included in Utah.
b Includes Oklahoma and Texas.
c Included in Kansas.
d Includes Colorado, Nevada, and Oregon.

Crude gypsum mined in the United States, 1880–1910.

	Short tons.		Short tons.		Short tons.
1880	90,000	1891	208,126	1902	816,478
1881	85,000	1892	256,259	1903	1,041,704
1882	100,000	1893	253,615	1904	940,917
1883	90,000	1894	239,312	1905	1,043,202
1884	90,000	1895	265,503	1906	1,540,585
1885	90,405	1896	224,254	1907	1,751,748
1886	95,250	1897	288,982	1908	1,721,829
1887	95,000	1898	291,638	1909	2,252,785
1888	110,000	1899	486,235	1910	2,379,057
1889	267,769	1900	594,462		
1890	182,995	1901	633,791		

Production of gypsum in the United States, 1906–1910, 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.
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
1910	53,815	110,325	2.05	368,014	559,172	1.52

Production of gypsum in the United States, 1906–1910, classified as to uses—Continued.

Year.	Sold as calcined plaster.			Total value.
	Quantity, in short tons.	Value.	Average price per ton.	
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
1910	1,583,669	5,853,532	3.70	6,523,029

Disposition of gypsum in the United States, 1909–10, by uses, in short tons.

	1909		1910	
	Quantity.	Value.	Quantity.	Value.
Sold crude:				
For Portland cement	260,433	$402,830	334,815	$522,693
For paint material	(a)	(a)	1,297	2,386
For plaster material	29,784	44,323	(a)	(a)
As land plaster	49,581	103,695	53,815	110,325
For other purposes	[b]2,057	1,661	[c]31,902	34,093
Sold calcined:				
For dental plaster	2,728	73,600	115	805
As plaster of Paris, wall plaster, Keen's cement, etc.	[d]1,438,706	5,070,334	[d]1,483,046	5,599,353
To glass factories	13,869	35,208	15,943	29,185
For Portland cement and other purposes	58,734	175,087	84,565	224,189
	1,855,892	5,906,738	2,005,498	6,523,029

a Included in "For other purposes."
b Includes some paint material.
c Includes some plaster material.
d Includes some dental plaster and other gypsum products.

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, Me. 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 1910 over those imported in 1909 was $76,974, as compared with an increase of $70,734 in 1909.

Gypsum imported and entered for consumption in the United States, 1906–1910, in short tons.

Year.	Ground or calcined.		Unground.		Value of manufactured plaster of Paris.	Total value.
	Quantity.	Value.	Quantity.	Value.		
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
1910	2,414	15,072	415,321	444,263	42,776	502,111

PRODUCTION IN OTHER COUNTRIES.

The following table gives the production of gypsum in other countries from 1905 to 1909, inclusive:

Production of gypsum in other countries, 1905–1909, in short tons.

Year.	France.		United States.		Canada.	
	Quantity.	Value.	Quantity.	Value.	Quantity.[a]	Value.
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	1,553,173	2,559,521	1,721,829	4,075,824	340,964	575,701
1909	1,460,271	2,426,110	2,252,785	5,906,738	473,129	809,632

Year.	United Kingdom.		German Empire (Bavaria).		Algeria.		Cyprus.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.[b]	Value.
1905	286,169	$400,717	50,978	$19,660	38,297	$98,420	17,890	$42,499
1906	252,030	362,761	55,956	22,011	30,809	85,446	23,069	55,658
1907	263,779	431,313	53,985	17,456	29,101	75,907	27,114	68,146
1908	255,714	431,551	56,563	18,953	28,109	66,537	23,511	57,561
1909	267,676	418,242	56,911	19,213	31,967	75,656	(c)	(c)

a Quantity sold. b Exports. c Figures not yet available.

CHARACTER OF GYPSUM.

There are several varieties of gypsum. Crystallized gypsum is known as selenite. Where pure it is colorless and transparent. Selenite is used to a limited extent for optical purposes. The crystals of gypsum belong to the monoclinic system, and are characterized by an easy cleavage parallel to the principal plane. Thin flakes of gypsum are flexible but are not elastic like mica flakes, to which they bear some resemblance.

Fibrous gypsum is termed satin spar. It is composed of an aggregate of parallel or radiating acicular crystals, and occurs in veins which intersect bodies of massive gypsum and its inclosing rocks. It ranges from colorless to white or pink, and has a pearly luster.

Rock gypsum is the form of gypsum of most extensive occurrence and commercial use. It generally consists of a mass of intergrown small crystals, in some cases too small to be seen without magnification. Rock gypsum has a wide variety of colors, such as gray, blue, brown, or nearly black, depending on the character and quantity of impurities present. The white or delicately tinted, even-grained varieties, termed alabaster, are found more rarely and are valued for sculpture and art work. Rock gypsum occurs in beds and lenses similar to strata of limestone. Seams and beds of shale are interbedded with the gypsum in many places, and along joint cracks and openings in the gypsum that have been enlarged by solution there are generally deposits of clay. Where impure gypseous material occurs in surface deposits in an earthy, granular condition it is known as gypsite.

Pure gypsum is a hydrated calcium sulphate having the 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 ($CaSO_4$) 79.1
  - Lime (CaO) 32.6
  - Sulphur trioxide (SO_3) 46.5
- 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 making plaster, will usually carry varying and often high percentages of such impurities as clay, limestone, magnesian limestone, quartz, and iron oxide. The earthy, granular material known as gypsite may carry 10 to 30 per cent of impurities.

Analyses.—The following analyses of rock gypsum and gypsite from various localities[1] are fairly representative of the materials used for plaster in different States. Silica, alumina, iron oxide, calcium 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 ($CaSO_4$).	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.

The hardness of gypsum is 2, as compared with talc, which is 1, and calcite, which is 3, in the Mohs scale of hardness. Gypsum crystals may be scratched with the finger nail. One part of gypsum dissolves in 415 parts of pure water at 32° F. and in 368 parts of water at 100.4° F., but a larger proportion of gypsum dissolves in water containing sodium and potassium chlorides.

Associated with gypsum is the mineral anhydrite, or anhydrous calcium sulphate, $CaSO_4$. It is often found interbedded with deposits of gypsum. On account of its composition it lacks the property of setting with water and its presence is consequently a disadvantage to the deposit of gypsum with which it is associated.

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, molding and casting plaster, stucco, cement plaster, flooring plaster, hard-finish plaster, etc. Refined grades of plaster are used in dental work, also as cement for plate glass during grinding, for making pottery molds, stereotype molds, molds for rubber stamps, and as an ingredient in various patent cements. A steadily increasing quantity is being used in the raw state as a retarder in Portland cement. Considerable quantities are ground without burning and used as land plaster or fertilizer; smaller quantities are used in the manufacture of paint, wall tints, crayons, paper, imitation meerschaum and

[1] Eckel, E. C., Cements, limes, and plasters, Wiley & Sons, 1905, pp. 53-54.

ivory, and as an adulterant. The pure white massive form, known as alabaster, is much used by sculptors for interior ornamentation, less, however, in this country than abroad.

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, or wood. 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, anhydrous 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 backing and surface for artificial marble and for ornamental moldings and castings, and its use as a wall plaster is increasing. Flooring plaster is another example of this type of plaster.

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.

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 free moisture and a certain definite portion of the combined water will be driven off, and the gypsum thus partially dehydrated is converted into the half hydrate, or 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 has therefore been driven off in the course of the heating. Dehydration to this extent takes place in two stages: When gypsum is first heated in kettles the free moisture is driven off at about 220° F., or a little higher, and the mass begins to boil and later settles. The temperature is then increased to about 290° F., at which a second boiling occurs and part of the combined water begins to be driven off. In practice it is found most economical of fuel and time to carry on the heating at the highest allowable temperatures, viz, between 350° F. and 396° F. The wide range of temperature at which the burning may be completed is probably due largely to the variation in the purity of the gypsum.

The general plan of preparing plaster of Paris and wall plasters comprises crushing and calcination. The size and weight of the machinery depend on the capacity desired. Certain of the plasters are reground after calcination. Wall plasters require the addition of retarders and of fiber, such as hair, wood, or asbestos. Crushing of the raw material is performed first in a coarse crusher. Rock as it comes from the quarry in lumps convenient for handling is broken to fragments about 1 inch in diameter. Both jaw and gyratory crushers are used. Next, the material is passed through a pot crusher, or "cracker," which operates similarly to a coffee mill, and delivers the material crushed to about pea size and smaller. Gypsite does not require this preliminary crushing.

At this stage the gypsum is ready for charging into rotary kilns if these are used for calcining, but if the kettle process is used in calcining the material is next run through a fine grinder. There are several types of mills employed for fine grinding. The oldest type, and one still common, is the horizontal burr mill, but this is being superseded in modern plants by vertical mills containing burr stones and emery blocks and by hammer mills and disintegrators of special types.[1] The size of particles is considered to have an influence on the setting properties of gypsum, and fine grinding has recently been advocated as advantageous by certain progressive manufacturers. The fine material that is ready for calcining is next charged into kettles. The kettles range generally in diameter from 8 feet to 10 feet. They are cylinders of boiler steel nearly square in vertical section and stand on a brick, stone, or concrete foundation. The bottoms are convex, rising about a foot in the center. These bottoms are usually of cast iron ranging in thickness from three-fourths of an inch at the edge to 4 inches in the center. The kettles are inclosed nearly to the top by masonry, with an open space between for the circulation of heat. The fire chamber is below the kettle, and the heated gases pass through ports into the open space at the base, then through horizontal flues through the kettle and out through a stack. Kettles are built with two or four flues. A kettle with four flues, measuring 10 feet in

[1] Illustrations of certain of these mills and other machinery used in the gypsum industry are given in Bulletin 143 of the New York State Museum on the gypsum deposits of New York, 1910, pp. 78–88.

diameter by about 8½ feet high, is considered to be capable of calcining 10 tons of ground gypsum into plaster at a single charge. Inside the kettle a vertical shaft propels paddles below and above the flues, which stir the gypsum constantly and prevent the hot mass from destroying the kettle bottom. There are generally at least two or more kettles in a mill. Three kettles are essential if it is desired to keep two kettles operating continuously, in order to compensate for time lost in making repairs. The kettles are generally worked in pairs with a feeding chute and a pit for the calcined product between the two. The calcined plaster is drawn off hot from the kettles and the hot pits are built of brick, stone, or concrete, as a precaution against fire. Intermediate between the crushers and the fine grinders there are usually storage bins, as well as between the fine grinders and the kettles. Screw conveyers and steel-bucket elevators move the material from point to point. After the material from the kettles has cooled sufficiently it is conveyed to screens, from which the fines go to stock bins and the oversize to regrinding mills, and thence to the stock bins. From the stock bins the material is moved to bins from which it is fed to a mixing hopper. To the plaster in this hopper definite quantities of retarder, hair, wood, fiber, sawdust, etc., are added, and the material is then fed by gravity into a machine which mixes the whole and discharges the product into sacks.

At present the great majority of plaster mills are equipped with calcining kettles, but an attempt has been made to provide a process that should be more economical of fuel and should eliminate the loss of time due to the interrupted operation of the calcining kettles. A cylindrical rotary kiln has therefore been devised in which the calcining process may be carried on continuously, and these kilns are in use in New York and in Oklahoma. The gypsum after passing through the "cracker" is delivered to a storage bin. From this bin the gypsum, in small lumps, is fed into the upper end of the rotary kiln, which is set on a slight incline. The kiln is turned slowly, and the gypsum gradually works its way down as the cylinder revolves, being lifted and dropped by angle irons attached to the inside. Hot gases from a furnace are forced by a fan into the brick chamber surrounding the cylinder, where they are mixed with sufficient air to give the desired temperature. From this air chamber the mixture of air and furnace gases is drawn by a fan through hoods into the interior of the cylinder, through which it passes in a direction opposite to that taken by the gypsum. The temperature of the interior is kept between 400° and 600° F., according to the character of the rock and the product desired. The hot plaster is discharged from the kilns into calcining bins, of which there are four to a kiln. These bins are built of masonry and lined with paving brick which have very little absorptive power. The material remains in the bin about 36 hours, during which time the free moisture not driven off in the cylinder is removed, as well as a further part of the water of crystallization. While the calcination is going on in the bin outside air is excluded, thus allowing the heat of the material to equalize itself throughout the mass. With the use of four bins the process is continuous; while one is being filled calcination is going on in the second and third, and the fourth is being emptied.

TRADE AND MANUFACTURING CONDITIONS.

Most of the gypsum producers reported that trade during 1910 was either as good as or better than in 1909. A few firms reported greatly increased trade, and a few reported that trade was not so good. The points where trade was not so good were principally in localities where competition is becoming acute. Prices in some localities were considered low, notwithstanding the satisfactory showing made in the average for the whole country.

The close of 1910 showed 80 mills operated in that year making either wall plaster or land plaster, or both, as compared with 79 in 1909. One new plant began operation in 1910 at Sigurd, Utah, as a producer of Keenes cement, and at the close of the year 6 new plants destined to produce wall plasters were under construction.

A summary of the equipment of plaster plants shows that there were 65 plants equipped with calcining kettles in operation in 1910, besides 2 plants equipped with rotary kilns, and 3 plants manufacturing Keenes cement. In all there were reported 190 kettles, ranging generally from 8 to 10 feet in diameter, and the total daily capacity was reported at 13,300 tons, or an average of 70 tons per kettle. This is more than two and one-third times the actual output of plaster. At 51 plants rock gypsum alone was used, and at 11 plants gypsite alone was used, while at 8 plants both rock gypsum and gypsite constituted the raw materials. The supply of gypsum for 40 plants was obtained from open quarries, in 27 places it was obtained from mines, and at 3 places combination quarries and mines were worked. At 55 of the plants coal was used as fuel, 13 used oil, and 2 plants reported the use of wood.

DISTRIBUTION OF GYPSUM DEPOSITS AND PLASTER MILLS, BY STATES.[1]

East of Mississippi River the producing localities are confined to central and western New York, southwestern Virginia, northern Ohio, and two widely separated areas in Michigan. A large unworked deposit has been reported in the swamps of Florida. West of Mississippi River gypsum deposits are both numerous and widely distributed. The material is mined in 15 of the Western States and also in Alaska, and plaster mills are in operation in at least 14 of these States.

Alaska.—The only extensive deposit of gypsum known in southeastern Alaska is situated on Gypsum Creek a mile from its mouth, at Iyoukeen Cove, on the east side of Chichagof Island. The gypsum beds apparently overlie the Carboniferous rocks exposed along the southwestern shore of Iyoukeen Cove and forming the ridge southwest of Gypsum Creek, though the area of contact is buried under deep gravel deposits along the beach and in the valley. The mountain ridge to the northeast is made up of a granitic mass intruding the older limestone and quartzite. Structurally the gypsum beds are folded and steeply tilted, and were probably laid down previous to the granitic intrusion. They are at present regarded as of Permian or Triassic age.

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[1] See map (Pl. XVI), in pocket.

The geology in the immediate vicinity of the gypsum beds is obscure, and neither footwall nor hanging wall of the deposit is exposed. Bluffs of a cherty limestone, striking northwest and dipping to the northeast, are exposed near the entrance to the tunnel at the lower mine workings on Gypsum Creek. The gypsum beds in the tunnel and lower levels have an east-west to N. 70° E. strike, with a northerly dip of 20° to 60°. Channels representing old watercourses and now filled with gravel wash are numerous throughout this deposit. These gravels resemble unconsolidated conglomerate beds and have been mistaken for both hanging and foot walls of the gypsum beds at points in the workings. A careful inspection of the gravels shows that the wash has the same character as that now in the creek bed. Of significance is the presence of cobbles of granite corresponding to the intrusive mass at the head of the creek, which invaded the area subsequent to the deposition of the gypsum beds.

This gypsum on the property of the Pacific Coast Gypsum Co. has been extensively developed during the last few years and large shipments of the rock are being made to the plaster mill at Tacoma, Wash., where it is prepared for the market.

Arizona.—Gypsum occurs at several localities in southern Arizona, the following being particularly noteworthy: (1) In the Santa Rita Mountains, Pima County, southeast of Tucson; (2) in the low hills along the course of San Pedro River, Cochise and Pinal Counties; (3) in the Sierrita Mountains, Pima County, south of Tucson; (4) in the foothills of the Santa Catalina Mountains, Pima County, north of Tucson; (5) on the Fort Apache Reservation, Navajo County. Commercial development has taken place on the second, fourth, and fifth of these localities. In 1910 gypsum quarried near Winslow, Navajo County, was shipped to plaster mills at Los Angeles, Cal., and a mill at Douglas utilized gypsum quarried near that place.

California.—In the Tertiary rocks of California gypsum is widely distributed. It is found throughout nearly all the coast ranges, particularly south of San Francisco Bay, in the foothills of the Great Valley, in the valleys of southern California, and in the Palen and Maria Mountains. In the Palen Mountains the deposits are probably of Paleozoic or earlier age. Deposits are known to occur in the counties of Fresno, Ventura, Kings, Monterey, Kern, San Luis Obispo, Santa Barbara, Los Angeles, San Bernardino, Riverside, and Orange.

In 1910 gypsum was ground for wall plaster or land plaster at 7 mills in California, as follows: One each at Amboy, Corona, King City, Los Angeles, 1 at Palmdale, and 2 at McKittrick. In addition, gypsum was mined in small quantities at Fillmore.

Colorado.—Gypsum-bearing localities in Colorado occur at intervals from the northern to the southern border of the State along the eastern foothills of the Rocky Mountains, also near Arkansas River, in Custer County, on Gunnison River in Delta and Montrose counties, along Grand and Eagle rivers in Eagle County, and along Frying Pan Creek in Eagle and Pitkin counties. Beds have also been prospected on Bear Creek, near Morrison, and 8 miles southeast of Morrison on Deer Creek. Quarries have been worked in the past near Perry Park and at the Garden of the Gods, near Colorado City. At present gypsum is being quarried at two places near Loveland, near Coaldale, west of Canon City, and at Ruedi, in the southern part of Eagle County. Plaster plants are located at all these places, except at Coaldale, the product from which is calcined at Portland.

Idaho.—Gypsum occurs in Washington County, Idaho, in the bluffs overlooking Snake River, about 10 miles northeast of Huntington, Oreg., which is the nearest town. Short tunnels and prospect pits have shown that the material consists of lenticular masses of rock gypsum banded with grayish and greenish material, possibly chloritic, and indicate thicknesses ranging from 6 to 20 feet or more. The hill slopes are too steep and there is too much stripping necessary to render extensive open quarrying practicable, but the material can be obtained by mining. A railroad that connects with the Oregon Short Line at Huntington passes down the Oregon side of Snake River within 2,000 feet of the gypsum outcrop, and near enough for the rock to be carried across the river on an aerial cableway. The deposits here are apparently of the same series that occur on the Oregon side of Snake River, a few miles farther south. The Washington County gypsum deposits are held by the Northwest Gypsum Plaster Co., of Huntington, Oreg.

Iowa.—The gypsum of Iowa is confined to a single area of 60 to 70 square miles near Fort Dodge, Webster County. The material occurs in one bed, which varies from 10 to 25 feet in thickness. It has been extensively worked, 6 plaster mills being now in operation in the district and 1 paint mill that utilizes gypsum.

Kansas.—The area in which gypsum is found in Kansas is an irregular belt extending northeast and southwest across the State. It is naturally divided into three districts, which, from the important centers of manufacture, may be named the northern or Blue Rapids area, in Marshall County; the central or Gypsum City area, in Dickinson and Saline counties; and the southern or Medicine Lodge area, in Barber and Comanche counties. A number of small areas have been developed between these, connecting more or less closely the three main areas. Seven mills operated in Kansas in 1910, 4 at Blue Rapids, 1 at Hope, 1 at Longford, and 1 at Medicine Lodge. The last-named plant produces Keenes cement.

Michigan.—Gypsum is at present worked in two distinct areas in Michigan, and a third locality may prove to be of importance in the future. The two producing areas are: (1) In the vicinity of Grand Rapids, and (2) at Alabaster, near Saginaw Bay. The third and as yet unexploited area is near St. Ignace, on the Upper Peninsula. Eight plants operated in 1910 in Michigan, 7 being near Grand Rapids and 1 at Alabaster.

Montana.—Rock gypsum deposits occur in the eastern foothills of the main Rocky Mountain Range in Cascade, Carbon, and other counties of Montana. There are several beds of gypsum ranging from a few feet to as much as 50 feet in thickness. Mills are located at Armington, Bridger, and Riceville, but only at Riceville was there any production in 1910. In many places the undeveloped gypsum beds are within 5 miles of railroads.

Nevada.—The best known gypsum deposits are in northwestern Nevada, near Moundhouse and Lovelocks. Large deposits also occur in southern Nevada, in the Spring Mountains and other ranges to the south. Four mills manufactured plaster in 1910, 2 at Moundhouse, 1 at Reno, and 1 at Arden, Clark County.

New Mexico.—The "Red Beds," which contain rock gypsum in many places, occur in large areas in New Mexico. The largest area is in eastern New Mexico, principally in the valley of the Pecos, but it connects with the area entering the State along Canadian River from northern Texas, Oklahoma, and Kansas. The central division of the "Red Beds" area is drained by the Rio Grande and its tributaries, and there is also an area in western New Mexico in the region of the Zuni Mountains. In addition to the areas of bedded gypsum there are accumulations of white gypsum sands in Otero County. Development of the vast resources of gypsum has been retarded by the limited markets and the long distances that the raw or manufactured materials must be transported. In 1910 a plaster mill was operated at Acme, Chaves County. Gypsum was quarried for use in Portland cement at El Rito and a small quantity was produced for other purposes at Alamogordo from the white sands.

New York.—The gypsum in New York State occurs as rock gypsum interbedded with shales and shaly limestones of the Salina formation. Several gypsum beds, separated by shale, usually occur in any given section. They are lenticular in shape, but of such horizontal extent that in any given quarry they are usually of practically uniform thickness. Those that are worked vary from 4 to 10 feet in thickness, but at Fayetteville a 30-foot bed is exposed. Underground mines furnish most of the gypsum in the western part of the State, but where the heavier beds outcrop in the eastern section they are quarried. The area in which the gypsum-bearing formations are found extends more than 150 miles through the central part of the State, the productive portion of the belt including parts of Madison, Onondaga, Cayuga, Ontario, Genesee, Monroe, Livingston, and Erie counties. The center of the industry is now in the western part of the State, and whereas the output of gypsum was formerly marketed largely as raw gypsum, principally for agricultural purposes, it is now converted mainly into wall plasters in plants operated in connection with the mines. Thirteen mills reported production of gypsum in either the raw or the calcined condition in New York State in 1910.

Ohio.—The gypsum deposits of Ohio which are of economic value consist of beds of rock gypsum occurring in the northwestern part of the State, in the Monroe formation of the Silurian system. On the north shore of Sandusky Bay, in Portage Township, Ottawa County, 1,500 to 2,000 acres of land have been thoroughly prospected with a core drill, and it has been shown that there are from 150 to 200 acres of workable gypsum in beds 3 to 7 feet in thickness. On the south shore of the bay, about 2½ miles northwest of the town of Castalia, drilling has shown the presence of another area of workable gypsum. The rock has been obtained from open quarries, drifts, and shafts. Considerable water is encountered in the workings so that it is necessary to use pumps. Two plants were operated in Ohio in 1910, both of them being in the area north of Sandusky Bay.

Oklahoma.—The gypsum in Oklahoma may be considered as occurring in four regions—(1) the Kay County region; (2) the main line of gypsum hills, extending from Canadian County northwest through Kingfisher, Blaine, Woods, and Woodward counties to the Kansas line; (3) the second gypsum hills, parallel with the main gypsum hills, and from 50 to 70 miles farther southwest, which extend from the Keechi Hills, in southeastern Caddo County, northwestward through Washita, Custer, Dewey, and Kay counties; and (4) the Greer County region, occupying the greater part of western Greer County and the extreme southeastern corner of Roger Mills

County. The deposits in Kay County consist of soft, earthy gypsum, or gypsite. In the other three regions rock gypsum predominates, although there are numerous localities where gypsite occurs in workable bodies. The reserves of rock gypsum in Oklahoma are enormous, but the gypsite deposits adjacent to railways are limited. In this State materials for plaster are obtained from open quarries rather than from mines. The supply for wall plaster is drawn largely from gypsite deposits, which are comparatively soon worked out. New deposits are, however, being discovered from time to time, and when mills have to be abandoned in one place new ones are built in others. Some ledges of rock gypsum are being quarried, but gypsite, so long as it lasts, will probably be regarded as preferable for wall plasters by practical plaster men in Oklahoma. The main reasons for this are that gypsite costs less to quarry, since it can be taken up rapidly by means of scrapers instead of requiring blasting and breaking, and that the material is often found to contain nearly, if not exactly, the right proportions of silica and other impurities to make a good wall plaster when calcined, and therefore does not require the addition of retarders. Gypsite that is unusually impure or that contains considerable surface soil may be brought up to the requisite standard by the addition of rock gypsum.

Ten plants produced gypsum, including that ground for land plaster, for wall plaster, and for plaster of Paris in Oklahoma in 1910, as follows: One each at Bickford, Cement, Marlow, McAlester, Eldorado, Okarche, Quinlan, Southard, Watonga, and Hitchcock.

Oregon.—Gypsum occurs in Oregon in two localities. One is on the eastern border of the State, near the middle point of the boundary line, on a ridge dividing Burnt River and Snake River, about 6 miles north of Huntington. The gypsum occurs here as elongated lenses in places 10 to 40 feet thick, interstratified in a sedimentary series of limestone and shale with a few intercalated strata of volcanic tuffs. The gypsum is in part white and crystalline, but contains in places thin strata and films of greenish chloritic mineral. The gypsum is worked mainly by open quarrying at present. The rock is carried down to the railroad on Snake River by means of an aerial cableway, 6,100 feet long, then carried by rail about 10 miles to a mill at Lime, where it is calcined to plaster.

Another deposit of gypsum occurs in Crook County near the town of Bend, but it has not yet been developed. It is reported that this material is in part gypsite and that it has been used as fertilizer.

South Dakota.—In the Black Hills uplift there is brought to the surface an elliptical outcrop of the "Red Beds" surrounding the high ridges and plateaus of the central portion of the Black Hills. The area is about 100 miles long by 50 miles wide, and the outcrop zone has an average width of 3 miles, except in a few districts where the rocks dip steeply and where it is much narrower. The formation consists mainly of red, sandy shale, with included beds of gypsum at various horizons, some of which are continuous for long distances, and others are of local occurrence. The thickness of the deposits varies greatly, but in some districts over 30 feet of pure white gypsum occur, and nearly throughout the outcrop of the formation the deposits are of sufficient thickness and extent to have commercial value. The gypsum beds are convenient of access from Hot Springs, Rapid City, Spearfish, Newcastle, and Edgemont. A plaster mill was formerly operated at Hot Springs, but the only operators reporting in 1910 were one plant near Rapid City and one at Spearfish.

Texas.—The largest area in Texas containing deposits of gypsum lies east of the foot of the Staked Plains, in northern Texas. The beds have an approximately northeast-southwest strike, and extend from Red River to the Colorado in an irregular line, the sinuosities of which are produced by the valleys of the eastward-flowing streams. This belt is a continuation of the deposits in Oklahoma.

In the eastern part of El Paso County, to the east of the Guadalupe Mountains, there is an area of gypsum which extends beyond the border of the State northward into New Mexico. It lies north of the Texas & Pacific Railroad and west of Pecos River. In a few localities this great plain of gypsum is overlain by beds of later limestone and conglomerate. The gypsum is conspicuously exposed along the course of Delaware Creek, a stream rising in the foothills of the Guadalupe Mountains and flowing eastward into the Pecos.

In the Malone Mountains, in El Paso County, there is a third area, which contains notable deposits of rock gypsum. This locality has the advantage of being situated near the Southern Pacific Railroad. The only area exploited for gypsum at present is in northern Texas. Three plants, 2 at Acme and 1 at Hamlin, were engaged in the manufacture of wall plaster in 1910. Keenes cement is made at one of these plants.

Utah.—The more important known deposits occur in the central and southern portions of the State, in Juab County, east of Nephi; in Sanpete and Sevier counties, near Salina; in Millard County, at White Mountain near Fillmore; and in Wayne County, in South Wash. They are all of the rock-gypsum type, except the one near Fillmore, which is in the secondary form of unconsolidated crystalline and granular gypsum blown up from dry lakes into dunes. Deposits are also known in Emery County, about 40 miles southeast of Richfield; in Kane County, near Kanab; in Grand County, between Grand River and the La Sal Mountains; in Sanpete County, near Gunnison; in the eastern part of Washington County, between Duck Lake and Rockville; and at other places. Enormous deposits of gypsum have also been reported from Iron County. In 1910 four mills produced plaster in Utah, 1 at Nephi, 1 at Levan, and 2 at Sigurd. Keenes cement is made at one of the mills at Sigurd.

Virginia.—All the workable gypsum deposits of Virginia occur in Washington and Smyth counties in the valley of the North Fork of Holston River. The area within which the known deposits are located is a narrow belt about 16 miles in length, extending from a short distance southwest of Saltville to a point about 3 miles west of Chatham Hill post office.

The material occurs as rock gypsum, interbedded with shale and shaly limestone of Carboniferous age. The beds of gypsum average 30 feet in thickness at the localities at which they are now worked. The rocks of the district dip at a high angle, usually between 25° and 45°, so that certain wells which have been drilled are in the gypsum for long distances, and accordingly immense thicknesses of gypsum have been erroneously reported, because the inclination of the deposits was not taken into account.

Through the entire area the dip of the gypsum beds is so high as to require mining, except at the surface.

The development of the gypsum industry in this area has been governed almost entirely by transportation facilities. The deposits at Saltville and Plasterco, which are on a branch of the Norfolk & Western Railway, furnished the principal output up to 1907. Recently a railroad 4 miles long has been built to North Holston, and the gypsum deposits at this point have been developed by shaft mining.

In 1910 two plaster mills reported production from Virginia, 1 at North Holston and 1 at Plasterco.

Wyoming.—The gypsum deposits of economic importance in Wyoming occur in the "Red Beds," which consist largely of red sandstone and shale. This formation outcrops about the base of many mountain ranges or is exposed by erosion as the core of small or secondary folds. In all there are about 1,500 miles of the gypsum-bearing formation exposed, and throughout this extent there are generally present beds of gypsum ranging from 5 to 20 feet thick, and in places reaching thicknesses of 30 to 50 feet. The material is generally found to be of excellent quality. Besides the rock gypsum there are secondary surficial deposits of gypsite which occur in depressions below the gypsum outcrops.

Three mills produced plaster in Wyoming in 1910, 2 of them at Laramie utilized gypsite as raw material and 1 at Red Butte worked rock gypsum.

CANADA.

Gypsum occurs in New Brunswick associated with Mississippian (lower Carboniferous) limestones, particularly large deposits being shown near Hillsboro, Albert County.

The gypsum deposits of Ontario occur in the form of beds, associated with shales and limestones, in the Salina formation. The principal exploited deposits are located along the valley of Grand River from Paris, in Grant County, to near Cayuga, in Haldimand County.

Extensive gypsum beds also occur in Devonian limestones along Moose and French rivers, near James Bay, but these deposits are as yet entirely undeveloped. A large deposit of gypsum occurs on Manitoba Lake and supplies material to a plaster mill in Winnipeg.

In Nova Scotia thick beds of gypsum occur near St. John Harbor, Port Bevis, and Baddeck Bay, associated with Carboniferous limestones.

Of the Canadian gypsum deposits those of New Brunswick and Nova Scotia are of greatest interest to American producers, for they have supplied large quantities of crude gypsum to plaster plants and paint mills located in the United States. Most of this Canadian gypsum is used in plants located in the seaboard cities, such as Brooklyn, N. Y., and Philadelphia, Pa., but a considerable quantity of it has been calcined as far inland as Syracuse, N. Y.

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PHOSPHATE ROCK.

By F. B. Van Horn.

INTRODUCTION.

There are at present five producing phosphate fields in the United States. In the order of quantity of production they are (1) Florida, (2) Tennessee, (3) South Carolina, (4) Arkansas, (5) Idaho, Wyoming, and Utah.

By far the largest of these fields is the one named last, where enormous deposits of high-grade phosphate rock are available for mining. The field next in available unmined rock is probably Tennessee, where large areas are underlain by deposits of high-grade rock. Florida has a large reserve tonnage, but at the present rapid rate of mining it will not be many years before the rock will be exhausted.

South Carolina has been mining phosphate rock since 1868, and the production has steadily declined since 1889, with the exception of two or three years, when a slight increase in production was noted.

Arkansas has never been much of a factor, and the deposits of this State are not of great extent.

FLORIDA DEPOSITS.

The Florida deposits occur in a general way along the Gulf coast. They are of three classes—hard rock, land pebble, and river pebble. Of these the land pebble is probably of most importance.

The age of these deposits has not yet been fully determined. All that can be said is that they have resulted from the alteration of phosphatic limestone of lower Oligocene age, and that probably all of the alteration has taken place during later geologic periods.

Hard rock.—The area of hard-rock phosphate at present productive lies in the western part of central peninsular Florida and extends as a narrow strip parallel with the Gulf coast in a general north and south direction from southern Suwanee and Columbia counties to Hernando County, a distance of 100 miles.

The hard rock occurs both as bedded rock and as a bowlder deposit in a soft matrix of phosphatic sands, clays, and other materials. The thickest bed known is at least 20 feet thick, and possibly much more than that.

The bowlders in the bowlder deposits vary in size from a few inches up to 8 or 10 feet, and lie embedded in all positions surrounded by sand and clay containing more or less phosphate of lime in finer particles, resulting from a general distribution of the disintegrated portions of the bowlders during deposition. The pockets in which they occur vary in size from a few feet to several acres. The phosphate content of this class of deposits is from 10 to 30 per cent of the mass, and the rock itself runs as high as 85 per cent of tricalcium phosphate.

Land pebble.—The pebbles making up this deposit range from minute size to that of a walnut. They are originally white, but become dark when subjected to water action. They are embedded in sand and are underlain by a stratum of tough, stiff, clayey material. Above the deposit is an overburden from 1 to 25 feet thick, consisting of sand and limestone bowlders. The proportion of phosphate to other rock of this class of deposits varies from 10 to 25 per cent.

The land pebble is found resting on Pliocene marls, and is probably a residual deposit resulting from the leaching out of lime carbonate from soft limestone and marls and the breaking up of the phosphate rock into small fragments, with possibly some concretions. These fragments are mainly residual, but they have probably also been moved and concentrated in valleys by rivers and the shallow sea. The pebbles are waterworn, and shark's teeth are plentiful in the deposit.

River pebble.—The river pebble deposits have resulted from water transportation of particles of phosphate rock and deposition in favorable places, probably during Pleistocene time.

TENNESSEE DEPOSITS.

These deposits occur in the central portion of Tennessee in Hickman, Maury, Williamson, Perry, and Lewis counties. They are of three classes as described by Hayes [1]—brown residual phosphate, blue bedded phosphate, and white phosphate.

Brown phosphate.—The brown phosphate is of Ordovician age and is the result of the leaching process to which the phosphatic limestones have been subjected. Surface waters bearing carbonic and other organic acids have dissolved and carried away a large part of the calcium carbonate forming the limestone, leaving the brown calcium phosphate as a residual product. It occurs as blanket deposits and as collar deposits—the former being a deposit which caps a small hill or slope and the latter, as the name indicates, being the leached outcropping edges of the phosphatic limestone. They occur at a number of horizons in workable quantities. The principal deposits are in the vicinity of Mount Pleasant, Tenn., where they have been worked since 1893. The brown rock as mined carries as much as 80 per cent tricalcium phosphate.

Blue phosphate.—The blue bedded phosphate is of Devonian age, and shows variations from oolitic through compact and conglomeratic to shaly forms. There is also a nodular variety which occurs in a greensand formation immediately overlying a black shale. The bedded rock occurs in seams varying from 1 to 50 inches in thickness, but the high-grade rock is rarely more than 28 inches thick. The phosphatic content ranges from 30 to 85 per cent tricalcium phosphate. The nodular variety is not so high, and does not pay to work except where the bedded rock is mined by stripping off the overburden.

[1] Hayes, C. W., and Ulrich, E. O., Columbia folio (No. 95), Geol. Atlas U. S. U. S. Geol. Survey, 1903.

White phosphate.—The white phosphate is of post-Tertiary age, and has been described by Hayes [1] as occurring in three different forms—stony, brecciated, and lamellar.

The stony phase is probably the result of replacement of calcium carbonate by the phosphate in places where conditions were favorable for such a transfer of material. This phase of the rock usually carries less than 50 per cent lime phosphate.

The brecciated form of the phosphate consists of masses of calcium phosphate cementing Carboniferous chert fragments.

The lamellar variety consists of plates of irregular shape and extent which were probably deposited in layers in large or small cavities.

The brecciated and lamellar forms carry as much as 85 per cent tricalcium phosphate. None of this white phosphate of Tennessee is now being mined.

SOUTH CAROLINA DEPOSITS.

The phosphates of South Carolina occur in a belt along the coast running back as far as 20 miles from the ocean, and extending from the source of the Wando River, in Charleston County, to the mouth of Broad River. The rock occurs in two forms—land rock and river rock.

Land rock.—The land rock is probably of Miocene age, and consists of so-called pebble rock, which is, in fact, a solid mass from which the calcium carbonate has been leached out and partially replaced by phosphate, leaving cavities which connect and penetrate through the rock, giving it the appearance of being made up of separate pebbles. The bed is from 1 to 3 feet thick and is overlain by a greensand marl.

River rock.—The river rock is so called because it is mined from river channels. It consists essentially of water-rounded fragments of the land rock.

The South Carolina rock is of comparatively low grade, running from 55 to 58 per cent tricalcium phosphate.

ARKANSAS DEPOSITS.

In Arkansas the only point at which phosphate rock is being mined is near Batesville, in Independence County. Here the bed is rather light gray, homogenous and conglomeratic, and contains small pebbles more or less angular in form. The bed is about 4 feet in thickness, and carries about 65 per cent tricalcium phosphate.

WESTERN DEPOSITS.

The deposits occurring in the Western States are in northeastern Utah, southwestern Wyoming, and southeastern Idaho. They are of Pennsylvanian age and occur in the Park City formation. They are by far the largest deposits in the United States, if not in the world.

Gale, Richards, and Blackwelder,[2] of the United States Geological Survey, have worked in the western phosphate field for two seasons, both on reconnaissance and on detailed geology. They divide the

[1] Hayes, C. W., Tennessee phosphates: Seventeenth Ann. Rept. U. S. Geol. Survey, pt. 2, 1896, pp. 513-550.

[2] Bull. U. S. Geol. Survey No. 430, 1910, pp. 457 and 536.

Park City formation into three parts—an upper cherty limestone, an interval of phosphatic shales, phosphate rock, and limestone bands, and an underlying limestone, usually massive and commonly containing much chert.

Immediately overlying the phosphatic shales is a massive ledge-forming stratum of chert or cherty limestone, and this is so prominent as to serve as a horizon marker from which to trace the outcrops of the phosphate beds themselves where they are not continuously exposed. It consists of black chert and dark cherty limestones, and varies from 80 to 200 feet in thickness.

The phosphate-bearing member of the Park City formation consists of 200 feet of massive brown to gray phosphatic shales and beds of phosphate rock with some limestone, and in places cherty bands in the upper part. Rounded or oval limestone nodules ranging from a few inches to several feet in diameter are characteristic of the phosphate beds and phosphatic shales. They consist of very dense, compact, fine-grained limestone, but carry a low percentage of phosphoric acid.

The limestone underlying the phosphate-bearing strata in the Park City formation is usually massive and of sandy composition, occurring in heavy-bedded strata which weather with a light-bluish granular or sandy surface. White calcite in small irregular crystalline patches is of rather common occurrence throughout this rock.

According to Gale and Richards's description, the rock phosphate itself is chiefly characterized by an oolitic texture, by which it can usually be recognized in the field. Rounded grains, built up in roughly concentric structure, range in size from the most minute forms visible to the naked eye or by the hand lens to pebble-like bodies half an inch in diameter; rarely larger. In unaltered specimens there is commonly no visible or distinct cementing of the oolitic grains, except where they occur scattered in a groundmass of foreign material. In the weathered condition, however, as the material is commonly found near the surface, the grains have a grayish color and are more or less distinct. The rounded ovules are also characteristically distinct on weather-polished bedding planes of the more oolitic rock.

The rock phosphate varies in color from coaly black to dull gray or iron-stained. Its float is characteristically marked with a thin film of bluish-white bonelike coating, resembling chalcedony in places, with reticulated markings; this is thought to be some secondary phosphatic mineral but has not yet been studied. This coating is useful in tracing the concealed outcrop in the field by means of scattered float or fragments to be found in the overlying soil. The black color which is common in these deposits is thought to be due to bituminous matter.

FIELD TEST FOR PHOSPHATE ROCK.

For the benefit of those who may search for phosphate rock the following simple test is given:

Place a small crystal of ammonium molybdate on the rock to be tested, then drop a little dilute nitric acid on the crystal. If the crystal turns yellow, it indicates the presence of phosphorus. The deeper the yellow the higher the phosphate content.

METHODS OF MINING.

FLORIDA.

Pebble rock.—The land pebble phosphate of Florida is mined by hydraulicking. If the overburden is of a nature to permit, it is removed by hydraulic giants. If it consists of bowlders, however, it is usually removed by steam shovel.

In case the giant is used a stream of water is forced against the bank at a high pressure. The material is disintegrated and carried to a sump hole from which it is taken by a centrifugal sand pump and carried to the waste bank. When it is necessary to use the steam shovel, the cost of mining usually is much greater.

After the removal of the overburden the phosphate itself is hydraulicked in the same way as the overburden. The giants wash the pebble rock into ditches which lead to the sump hole. From here one sand pump takes it up to the washer where a second one discharges the material at the top of the washer. The pump and motor in the pit are on skids and protected by temporary shelter, so they can easily be moved from one part of the pit to another.

The washer generally used has been described by H. E. Memminger, from whose paper the following extracts are quoted:[1]

The general design of washers throughout the district is similar, but in details of construction they vary widely. They all maintain the general scheme of pumping the rock-bearing matrix into a separator where the pebble is separated from the clay balls, large sand rocks, and other large débris; passing the rocks through log agitators; and finally passing it over or through rinsing screens. But the variations come in the number of sets of logs, number and type of screens, and final method of disposing of the rock.

One of two types has been used on all plants with which the writer has been connected, both the same as regards the washing part, but differing in that one is on a floating structure, or dredge, while the other is on land, or the land type, as it is called. * * * The matrix is pumped up into the separator by tandem 10 by 8 inches centrifugal sand pumps. * * * This separator is a cylinder 12 feet long by 48 inches in diameter, punched "hit and miss" with 1-inch round holes. It is inclined on a slope of 1 on 6 and makes about 12 revolutions per minute. As none of the pebble phosphate rock is of such a size as to be retained by a 1-inch hole, approximately all of the pebble passes through, while the larger clay balls, etc., are retained and worked down into a trough where they are carried off by a stream of water continually supplied from pipes.

The pebble rock is caught on an adjustable screen * * * and washed down into the logs. This screen is 18 feet long by 6 feet wide, punched "hit and miss" with $\frac{1}{16}$-inch by $\frac{1}{2}$-inch perforations, and inclined on a slope of approximately 1 on 12. It is made with the higher end adjustable in order to accommodate the slope to the various grades of rock. Material, such as sand, dirt, etc., that passes through the screen is carried to the same trough that receives the débris from the separator.

The logs in this type of washer are four in number, arranged in pairs. The pairs are identical in arrangement, so a description of one set will suffice for both. They are simply blades or flukes bolted to 8 inch by 18 feet cast-iron pipes, and caused to rotate in opposite directions by means of spur gears. * * * These gears are on a 6-inch shaft bolted with flange unions to the 8-inch pipe logs. The logs are spaced 36 inches apart, center to center, and revolve at 25 revolutions per minute. The blades are just of sufficient length to miss each other in rotating. The pair of logs are set on an upward incline of 1 on 24 and depend on the pitch of the rotating blades to push the rock forward and into the chutes. The inclosing wooden box is kept full of running water with a discharge opening in the rear. The logs agitate the material, mixing and washing it thoroughly, with the same motion that forces it forward. The débris-laden water, as already stated, escapes through an opening in the rear of the logs, and is carried away in troughs.

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[1] Eng. News, vol. 60, No. 16, Oct. 15, 1908.

From the first pair of logs the rock, now partially cleaned, passes into a revolving rinsing screen where it receives a thorough rinsing. This screen is a double cylinder 12 feet long. The outer shell is 48 inches in diameter and the inner 36 inches, and both are perforated the same as the flat screen already described—that is, $\frac{1}{16}$ inch by $\frac{1}{2}$ inch. They are inclined downward on a slope of 1 on 12 and rotate at 12 revolutions per minute. Water pipes, perforated in rows so as to distribute the water along the whole length of the screens are run both inside and out. The débris passing through these screens is caught in a wooden trough and carried away. It has been found that, to facilitate the passage of the rock through the screen, it is necessary to introduce flights to assist gravity down the slope.

From the screens the rock falls into another set of logs, the same in every detail as the first; passes from them into another rinsing screen the same as the last, and thence into the receiving hopper.

From the receiving hopper the now thoroughly cleaned rock has two routes which it may follow. When cars are available they are run under the hopper and the rock is discharged directly into them through a gate in the bottom. In case, however, there is delay in getting the cars spotted an elevator, driven by a friction clutch from the main driving shaft, delivers the rock into a bin joining the washer. Cars may then be run under this bin and loaded through bottom gates.

The washed rock is usually run up on an elevated track and dumped into a hopper from which it is taken up into the wet bins by an elevator. From these bins it is drawn by chutes leading to another elevator which takes it up to another hopper which feeds it directly into the driers.

Mr. Memminger describes the driers as follows:

The driers are of the revolving cylinder type with diaphragms, flights, and showering shelves similar to, though smaller than, the ones used in cement manufacturing. * * * They are 30 feet long by 52 inches inside diameter and make 10 revolutions per minute. They are fed from the cold or smoke-box end, and discharge the rock from a flare end just outside the furnace. This type of drier has a capacity of about 150 tons per 12 hours. * * *

The dry rock is carried from the mill elevators to the dry bin by a pan conveyor. This conveyor discharges into a sheet-iron hopper holding about 3 tons. Tracks run along both sides of the bin converging at the center, and immediately beneath the hopper, on a scale platform, 1-ton side-dump cars are run on the platform, the hopper gate opened, and the rock allowed to run in until the automatic buzzer announces that a ton has run in.

This car is then pushed to the proper place and dumped. The rock is then ready for shipment.

Hard rock.—The hard rock is mined both by pick and shovel and by dredging. As a rule the overburden is removed by hydraulic giants, and the phosphate rock is picked out, loaded into cars, and hauled to the top of the washer. The washer is of the same general type as that used in the pebble districts.

The Holder mine, near Inverness, affords a good example of mining by dredge. Here the overburden is first removed by hydraulicking, and the dredge is put to work on the rock. The deposit at this mine is a bowlder deposit, and many of the bowlders are so large that they must be broken before washing. This is accomplished by blasting the rock on the dipper. It is then dumped on small cars which run up an incline to the washer. At the top of the washer is a set of "grizzly" bars through which the rock passes to the washer. The washer is of the usual type, but after being washed the rock is run on a revolving picking table where any clay or limestone which may remain are removed by hand picking. The phosphate rock is then conveyed to a burning shed where it is kiln dried. A layer of rock about 6 or 8 inches deep is placed over the floor of this shed; on the top of this is placed a layer of wood about 2 feet thick, and the kiln is filled to the top with the wet rock. The wood is then fired, and in about 30 days the rock is thoroughly dried and ready for shipment.

River pebble.—This class of phosphate rock has not been mined in Florida during the last two years.

SOUTH CAROLINA.

Land rock.—The land phosphate rock of South Carolina is mined in two ways, according to the thickness of overburden, which varies from 3 to 18 feet. Where the overburden is heavy it is removed by steam shovel, which runs on its own track. As a space is cleaned in front, the track is removed from behind and placed forward. Following the steam shovel, but placed upon the bank, is a steam hoist with a clamshell dipper. The dipper is let down on the phosphate rock, grabs a mouthful, and swings it over and dumps it on flat cars, which carry it to the washer.

After the phosphate rock has been mined out for a sufficient distance across a field, the steam shovel is turned around and started back, opening up another portion of the rock for mining. The overburden from this rock is dumped into the ditch left from the previous operation, and so the process is repeated until all the rock is mined out.

When the overburden is thin it is removed by steam shovel, but the rock itself is mined by hand and loaded into buckets, which are hoisted and dumped on flat cars which carry it to the washer.

The washer and kiln used in South Carolina are very similar in character to those used in the hard rock mining in Florida.

River rock.—The South Carolina river rock is mined by a dredge which dumps the rock into the washer. The washer is on a float and consists usually of only one screen and a picking table. The washed rock is dumped on barges and hauled to the market.

TENNESSEE.

Brown rock.—This rock is mined by stripping the overburden with a steam shovel and getting the rock out by pick and shovel. It is loaded into carts, dumped into cars, and carried up an incline to the washer, from which it goes to a rotary drier. Some of this rock is burned in kilns instead of rotary driers.

Blue rock.—This rock is mined by underground methods where the rock above is suitable for a roof. The blue rock is blasted and loaded on cars, which are hauled by mule power to an incline at the top of which the rock is dumped on a Bell crusher. From here it is run through rotary driers and dumped into elevator buckets which carry it up to a second rotary crusher which reduces it to a size as small as one-fourth inch. It is then carried by conveyor to a rotary screen which separates it into what is termed sand, pebble, and rock. Connected with this screen is a dust collector, which carries the dust into a dust chamber. The dust thus saved is a very high grade phosphate rock.

ARKANSAS.

The Arkansas rock is mined at only one place near Batesville. Underground mining is necessary and the rock is blasted and loaded on mine cars and carried to the dump. The bed at this place is about 4 feet thick.

WESTERN DEPOSITS.

The western phosphate rock has been mined only to a limited extent as yet. Near Montpelier, Idaho, it occurs dipping at an angle corresponding with the slope of a hill. The rock is blasted first, and simply rolls down the incline to a storage house where it is loaded into wagons and hauled to the cars. This rock is bedded rock in place, and needs no washing. It is shipped to the Pacific coast and manufactured into fertilizer.

This simple method of mining, however, applies only at this particular place. When the field is developed most of the mining will be carried on underground.

PRODUCTION.

The production of phosphate rock in the United States in 1910 was considerably larger than in 1909. In 1910 the total marketed production was 2,654,988 long tons, valued at $10,917,000, as compared with 2,330,152 tons, valued at $10,772,120 in 1909, an increase in quantity of 324,836 tons, or 13.9 per cent, and in value of $144,880, or less than 2 per cent. The increase was mainly in Florida rock, although the Tennessee production also showed a considerable gain. The average price of the rock was $4.11 in 1910 as against $4.62 in 1909, a decrease in 1910 of 11 per cent.

The following table shows the total production of phosphate rock in the United States from 1867 to 1910:

Marketed production of phosphate rock in the United States, 1867–1910, 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	1910	2,654,988	10,917,000
1898	1,308,885	3,453,460			
1899	1,515,702	5,084,076	Total	36,579,419	150,404,246

The production of the different classes of phosphate rock, by States, in 1909 and 1910 was as follows:

Production of phosphate rock in the United States, 1909–1910, based on the quantity marketed.

State.	1909			1910		
	Quantity (long tons).	Value.	Average price per ton.	Quantity (long tons).	Value.	Average price per ton.
Florida:						
Hard rock	513,585	$4,026,333	$7.84	438,347	$3,051,827	$6.96
Land pebble	1,266,117	4,514,968	3.56	1,629,160	5,595,947	3.43
River pebble	0	0	....	0	0	....
Total	1,779,702	8,541,301	4.79	2,067,507	8,647,774	4.18
South Carolina:						
Land rock	201,254	888,611	4.41	[a] 179,659	733,057	4.08
River rock	6,700	21,975	3.28	([b])	([b])	....
Total	207,954	910,586	4.37	179,659	733,057	4.08
Tennessee:						
Brown rock	266,298	1,011,028	3.79	329,382	1,262,279	3.83
Blue rock	66,705	275,165	4.12	[c] 68,806	241,071	3.50
White rock	0	0	....	0	0	....
Total	333,003	1,286,193	3.86	398,188	1,503,350	3.78
Western States	[d] 9,493	34,040	3.58	[e] 9,634	32,819	3.41
Grand total	2,330,152	10,772,120	4.62	2,654,988	10,917,000	4.11

[a] Includes small quantity of river rock.
[b] Included in land rock.
[c] Includes Arkansas.
[d] Includes Arkansas, Idaho, Utah, and Wyoming.
[e] Includes Idaho, Utah, and Wyoming.

These figures are based on the marketed product. The actual output mined in Florida during 1910 was 1,994,726 long tons; in South Carolina it was 195,146 long tons; in Tennessee and Arkansas it was 426,188 long tons, and in Idaho, Utah, and Wyoming it was 10,734 long tons—a total of 2,626,794 long tons mined in 1910.

PRODUCTION BY STATES.

FLORIDA.

The large increase in production was mainly in Florida. In 1910 the production in this State was 2,067,507 long tons, an increase over 1909 of 287,805 tons, or 16.2 per cent. The increase was entirely in the land pebble, 363,043 tons more of this class of rock being produced in 1910 than in 1909. The production of hard rock fell off 75,238 long tons. No river pebble was mined. The increase in total value of product amounted to $106,473.

The price of hard rock was $6.96 in 1910 as against $7.84 in 1909, and that of land pebble was $3.43 in 1910 as compared with $3.56 in 1909. The average price in 1910 was $4.18 as compared with $4.79 in 1909. During 1910 Florida produced 77.9 per cent of the phosphate rock mined in the United States.

The quantity and value of each variety of phosphate rock produced in Florida from 1906 to 1910, inclusive, based on the marketed product, are shown in the following table:

Phosphate rock marketed in Florida, 1906–1910, classified by grades, in long tons.

Year.	Hard rock.		Land pebble.		River pebble.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
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
1910	438,347	3,051,827	1,629,160	5,595,947			2,067,507	8,647,774

SOUTH CAROLINA.

The production of phosphate rock from South Carolina in 1910 showed a decrease from that in 1909 of 28,295 long tons, or 13.6 per cent. The production in 1910 was 179,659 tons, valued at $733,057; and in 1909 it was 207,954 tons, valued at $910,586. Practically the entire product was land rock. The average price per ton for South Carolina rock was $4.08 in 1910 as compared with $4.37 in 1909. In 1910 South Carolina produced 6.8 per cent of the entire phosphate rock mined in the United States.

The quantity and value of phosphate rock marketed in South Carolina from 1906 to 1910, inclusive, is shown in the following table:

Phosphate rock marketed in South Carolina, 1906–1910, classified by grades, in long tons.

Year.	Land rock.		River rock.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
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
1910	[a] 179,659	733,057	([b])	([b])	179,659	733,057

[a] Includes a small quantity of river rock. [b] Included in land rock.

TENNESSEE.

Tennessee showed a slight reaction in its phosphate rock production in 1910 from the slump in production in 1909. The total production in 1910 was 398,188 [1] long tons, valued at $1,503,350, as compared with 333,003 long tons, valued at $1,286,193 in 1909. This represents a gain of 65,185 tons, or 19.6 per cent, in quantity and of $217,157, or 16.9 per cent, in value. The price per ton of brown rock increased from $3.79 in 1909 to $3.83 in 1910; while that of blue rock decreased from $4.12 in 1909 to $3.50 in 1910. The average price per ton of all rock decreased from $3.86 in 1909 to $3.78 in 1910. Tennessee furnished 15 per cent of the entire production of the United States in 1910.

[1] This figure includes a small production from Arkansas, which has been included with Tennessee on account of the fact that there was only one producer in Arkansas.

The following table shows the tonnage and value of each grade of Tennessee phosphate rock marketed from 1906 to 1910, inclusive:

Phosphate rock marketed in Tennessee, 1906–1910, classified by grades, in long tons.

Year.	Brown rock.		Blue rock.		White rock.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
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
1910	329,382	1,262,279	[a] 68,806	241,071	....	....	[a] 398,188	1,503,350

[a] Including a small quantity from Arkansas.

WESTERN STATES.

The production of phosphate rock from these States in 1910 was 10,734 long tons, or less than one-half of 1 per cent of the total production in the United States for that year.

IMPORTS.

The following table shows the imports of fertilizer into the United States for the years 1906 to 1910, inclusive:

Fertilizers imported and entered for consumption in the United States, 1906–1910, in long tons.[a]

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.	
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
1910	33,565	667,870	585,827	2,803,933	413,918	5,782,804	9,254,607

[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 1910 there were exported 1,083,037 long tons of phosphate rock having a value of $8,234,276. This is an increase both in quantity and value over 1909 when 1,020,556 long tons, valued at $7,644,368, were exported.

WORLD'S PRODUCTION.

The world's production of phosphate rock for the years 1907 to 1909, inclusive, was as follows:

World's production of phosphate rock, 1907–1909, by countries, in metric tons.

Country.	1907		1908		1909	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Algeria	373,763	$2,183,404	452,060	$2,639,940	345,385	$1,999,779
Aruba (Dutch West Indies)	36,036	(a)	29,061	(a)	(b)	(b)
Belgium	182,230	332,114	198,030	355,897	205,260	460,349
Canada	748	6,018	1,448	14,794	905	8,054
Christmas Island (Straits Settlements)	112,147	(a)	110,849	(a)	(b)	(b)
France	431,237	1,876,736	485,607	1,880,435	397,908	1,493,099
Norway	(b)	....	....			
Spain	3,547	17,807	(b)	....	....	....
Tunis	1,069,000	4,547,842	1,300,543	5,531,624	1,300,000	(a)
United Kingdom	33	224	9	68	4	29
United States	2,301,588	10,653,558	2,424,453	11,399,124	2,367,434	10,772,120

a Value not reported. b Statistics not yet available.

POTASH SALTS: THEIR USES AND OCCURRENCE IN THE UNITED STATES.

By W. C. Phalen.

INTRODUCTION.

The many inquiries that have come to the Geological Survey for official information regarding American sources of potash have rendered advisable the publication of the available data on this subject. Chapters on potash salts were published in the annual reports on mineral resources of the United States for 1887 and 1904. The more important statements in those summaries are here republished and expanded in the light of later observations and other information procured by the Survey geologists, chemists, and statisticians.

Potash salts are used extensively in the United States. They are essential to numerous industries that are vitally connected with the welfare of the American people—the most notable being the fertilizer industry. They are used also in the manufacture of glass, in certain kinds of soap, in some explosive powders, and in the chemical industries, including the manufacture of alum, cyanides, bleaching powders, dyestuffs, and other chemicals, among which are arsenite of potassium, bromide of potassium, chlorate of potassium, permanganate and manganate of potassium, nitrate of potassium, and silicate of potassium.

DOMESTIC POTASH INDUSTRY.

Practically all the potash salts of mineral origin consumed in the American industries at present are imported from abroad, chiefly from Germany. There was a time in the history of the potash industry, however, when the United States produced a large part, if not all, of the potash it consumed. The burning of wood and the lixiviation of the resulting ash to extract the potash, though of minor importance so far as the monetary value of the product is concerned, is one of the oldest of the purely chemical industries in this country. Cognizance was taken of it in the census reports as early as 1850, so that data are available for comparing the condition of the industry for each decade since that year. In the following table are given the quantity and value of potash produced in the United States from 1850 to 1905:

Potash salts produced in the United States, 1850 to 1905.[a]

Census.	Number of establishments.	Product. Quantity.	Product. Value.	Average price per pound.
		Pounds.		
1850	569	....	$1,401,533	....
1860	212	....	538,550	....
1870	105	....	327,671	....
1880	68	4,571,671	232,643	$0.051
1890	75	5,106,939	197,507	.039
1900	[b] 67	3,864,766	178,180	.046
1905	[b] 39	1,811,037	104,655	.058

[a] Munroe, C. E., Bull. 92, Census of Manufactures, Bur. Census, 1908, p. 38.
[b] Includes establishments engaged primarily in the manufacture of other products.

According to C. E. Munroe,[1] the figures given above show a constant decrease in the total value of the potash produced in this country since 1850 and a steady decrease in the quantity of the product since 1890.

This seems quite reasonable, in consideration of the destruction of the forests during recent years and the resulting decrease in the quantity of ashes readily available for the manufacture of potash; also in consideration of the decrease in the native fertility of the soil, with which has come an inclination to return potash to the soil as it occurs in the ashes rather than to extract and market it; and also in consideration of the cheapening of soda or hard soaps and increased facilities for bringing them to agricultural communities, whereby the temptation to extract potash from ashes for the manufacture of potash or soft soaps is lessened. These causes, combined with the comparative cheapness of foreign potash, tend to destroy the domestic industry. The data given in the above table indicate that the industry is a waning one and that it may come to be of so slight importance as not to warrant separate consideration in subsequent censuses, unless other causes, recently set in operation, shall revive it in another form.

IMPORTATION OF POTASH SALTS.

The potash industry has not been revived in the United States thus far, and the great bulk of the potash salts now used are imported. The following table shows the magnitude of the importation of potash salts for the years 1900, 1905, and 1910:

Imports of potash salts for the calendar years 1900, 1905, and 1910, in pounds.[a]

[Figures from Bureau of Statistics.]

	1900		1905		1910	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Pounds.		Pounds.		Pounds.	
Chlorate	1,243,612	$68,772	....	....	....	....
Chloride	130,175,481	1,976,604	214,207,064	$3,326,478	381,873,875	$5,252,373
Nitrate (crude and refined)	10,545,392	276,664	9,911,534	304,596	11,496,904	333,854
All other, including carbonate (crude and refined), bicarbonate, caustic (crude and refined), chromate and bichromate, cyanide, hydriodate iodide, iodate, permanganate, prussiate (red and yellow), sulphate (crude and refined)	54,904,088	1,407,303	82,935,532	1,891,081	116,820,873	2,777,396
Total	196,868,573	3,729,343	307,054,130	5,522,155	510,191,652	8,363,623
Increase	....	....	110,185,557	1,792,812	203,137,522	2,841,468
Percentage of increase	....	....	55.96	48.07	66.15	51.45
Kainite, "kyanite," and kieserite, and manure salts[b]	520,605,120	1,508,217	830,903,360	3,116,884	1,288,199,360	3,251,511

[a] This table is based on total imports for the calendar year, not, as nearly all the import tables in this volume, on imports for consumption for the calendar year.
[b] These figures are for the fiscal years.

[1] Op. cit., pp. 38 et seq.

THE CHEMICAL MANUFACTURES IN THE UNITED STATES DEPENDENT ON IMPORTED POTASH SALTS.

POTASH.

Under the head of potash are included potassium carbonate and caustic potash. Potassium carbonate is made from potassium chloride by the LeBlanc process, in the same way as soda ash from salt, but the ammonia process can not be employed, because the acid carbonate of potassium ($KHCO_3$) is soluble in ammoniacal solutions and does not precipitate. The material is sold in the trade under the name potash or pearlash and is used chiefly in the glass industry, in the manufacture of caustic potash, and in the manufacture of chromates of potassium. A considerable quantity is bought by soap makers and causticized, the solution being used for soft soaps.

Caustic potash (KOH) is made in a similar manner to caustic soda. It is much more deliquescent than the corresponding sodium compound and is generally made where it is to be used. In soap making it was formerly customary to saponify the fat with caustic potash and then to add common salt. An interchange between the potassium and sodium took place, the result being a hard sodium soap. But as soda is now cheaper than potash and yields a hard soap directly, potash soaps are used only for special purposes.

The consumption of potash or pearlash in the glass industry of the United States at the census of 1890 was 2,544,978 pounds, valued at $135,047, and at the census of 1900, 4,406,211 pounds, valued at $186,047. The percentages of increase in quantity and value are, respectively, 74 and 38. The quantity of potash used in the soap industry at the census of 1905 was 4,453,800 pounds, valued at $191,933, but this does not include the potash produced and consumed in the same establishments in the manufacture of soft soap. Glass and soap making are two of the industries in which the largest quantities of potash are used.

The following table shows the imports of potash and ashes for three years—1904, 1905, and 1910:

Imports of potash and ashes, 1904, 1905, and 1910.

Year ending June 30—	Imports of bicarbonate of potash.		Imports of carbonate of potash.			
			Crude or black salts.		Refined.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*		*Pounds.*	
1904	93,769	$4,778	8,193,872	$224,396	13,586,306	$397,104
1905	76,983	4,504	7,166,569	218,816	13,687,083	440,139
1910	334,300	16,633	8,407,373	263,643	9,036,267	303,917

Year ending June 30—	Imports of caustic or hydrate of potash.				Imports of ashes (wood) and lye of, and beet-root ashes (value).
	Not including refined, in sticks or rolls.		Refined, in sticks or rolls.		
	Quantity.	Value.	Quantity.	Value.	
	Pounds.		*Pounds.*		
1904	4,810,993	$194,839	36,048	$4,879	$62,641
1905	5,269,804	217,041	22,313	2,537	60,713
1910	8,785,491	358,855	141,430	11,095	60,220

ALUMS.

In the manufacture of potash alum ($K_2SO_4.Al_2(SO_4)_3.24H_2O$), large quantities of potassium sulphate are used. On the addition of the potassium sulphate to the sulphate of alumina, the potash alum crystallizes out in extremely pure form. Alum is extensively used in the dyeing industry as a mordant and by paper makers and leather dressers. It is also used in making pigment lakes, clarifying turbid liquids, and precipitating sewage, and for hardening plaster of Paris casts, etc. A small quantity is used in medicine. The following table gives the quantity and value of potash alum manufactured in the United States at the censuses of 1900 and 1905. The figures for 1910 are not yet available:

Potash alum manufactured in the United States, 1900 and 1905.

	Quantity.	Value.
	Pounds.	
1900	14,200,393	$215,004
1905	10,307,154	156,448

CYANIDES AND DERIVED COMPOUNDS.

The class of cyanides comprises potassium cyanide, sodium cyanide, and other simple cyanides, including "cyan-salt," a mixture of potassium and sodium cyanides; potassium ferrocyanide (yellow prussiate of potash); potassium ferricyanide (red prussiate of potash); there are also the cyanates and ammonium and potassium sulpho-cyanates, etc.

Potassium cyanide (KCN) is generally made by fusing potassium ferrocyanide with potassium carbonate until the evolution of gas ceases. The following is the reaction:

$$K_4Fe(CN)_6 + K_2CO_3 = 5KCN + KCNO + CO_2 + Fe.$$

The metallic iron that is produced sinks to the bottom of the crucible, and the fused mixture of cyanide and cyanate is run off. The addition of powdered charcoal reduces part of the cyanate to cyanide. The product thus prepared is pure enough for many purposes. The commercial salt always contains cyanate and carbonate and is sold in various grades, depending on the purpose for which it is to be used. The best quality contains about 98 to 99 per cent KCN, but ordinary grades contain only 65 to 70 per cent. It is a very powerful reducing material when heated with reducible substances, and hence its use as a flux. It is extremely poisonous, either when taken internally or when introduced directly into the blood. It is extensively employed in electroplating as the solvent in the bath, forming soluble double cyanides with gold, silver, copper, and other metals. It is also used as a flux in assaying and metallurgy. Its greatest use at the present time is for the recovery of gold from low-grade ores and the tailings of other reduction processes. A weak solution is used to dissolve the gold, forming aurous potassium cyanide (AuCN.KCN). It was formerly used in photography for "fixing" the image, but for this purpose it has been largely replaced by sodium thiosulphate.

Potassium ferrocyanide ($K_4Fe(CN)_6.3H_2O$), also called yellow prussiate of potash is made by fusing together potassium carbonate, iron borings, and nitrogenous organic matter of any kind, such as ıorn, hair, blood, wool waste, and leather scraps. The material in ts pure form is produced in splendid large lemon-yellow crystals. [t is not poisonous. It is largely used for making Prussian blue; in ɜalico printing and in dyeing; for case-hardening iron; for making ɔotassium cyanide and ferricyanide; and to a small extent in explo- ɜives and as a chemical reagent.

Potassium ferricyanide, or red prussiate of potash (K_3FeCN_6), is ısually made by passing chlorine gas into a solution of the ferro- ɔyanide until ferric chloride no longer forms a precipitate, but pro- luces only a brown color in the liquid. It may also be made by ɜxposing the dry powdered ferrocyanide to chlorine until a test por- ;ion dissolved in water gives nothing but a brown color, with ferric ɔhloride. With ferrous salts, it gives the blue pigment Turnbull's ɔlue. Its solution with caustic potash is a powerful oxidizing liquid ınd as such is used in calico printing for a "discharge" on indigo and ɔther dyes. It also forms part of the sensitive coating of blueprint ɔapers. It has been recommended for use with potassium cyanide ɜolution in gold extraction.

The following table shows the magnitude of the cyanide industry n the United States at the censuses of 1900 and 1905. The figures 'or the census of 1910 are not yet available.

Cyanides manufactured in the United States, 1900 and 1905.

	1900	1905	Increase.	Per cent of increase.
ʖuantity....pounds..	8,460,989	11,196,318	2,735,329	32.3
'alue....	$1,595,505	$1,710,823	115,318	7.2
'alue per pound....	$0.189	$0.153	....	....

FERTILIZERS.

The class of fertilizers comprises numerous chemical compounds, ımong them the so-called complete fertilizers, which consist of super- ɔhosphate of lime, potash salts, and ammoniacal compounds or ıitrates. The following table gives the quantity and value of com- ɔlete fertilizers manufactured in the United States at the censuses of .900 and 1905, together with the amount and percentage of increase. The figures for the census of 1910 are not yet available:

Complete fertilizers manufactured in the United States, 1900 and 1905.

	1900	1905	Increase.	Per cent of increase.
ʖuantity....tons[a]..	1,478,826	1,603,847	125,021	8.5
'alue....	$26,318,995	$31,305,057	$4,986,062	18.9

[a] The ton used in this report is the short ton=2,000 pounds, except where otherwise stated.

The following table gives the quantity and value of the principal ɔotash materials used in fertilizers in the United States at the two ensuses cited, with the amount and percentage of increase, the igures for the census of 1910 not being available. This table in- ludes only the materials used in the principal establishments in he United States.

Principal potash materials used in fertilizers in the United States, 1900 and 1905.

	1900	1905	Increase.	Per cent of increase.
Kainite:				
Quantity....tons..	54,700	190,493	135,793	248.3
Value....	$520,833	$1,891,073	$1,370,240	263.1
Potash salts:				
Quantity....tons..	....	122,107	....	....
Value....	$3,098,400	$3,606,701	$508,301	16.4
Nitrate of potash:				
Quantity....tons..	884	1,160	276	31.2
Value....	$32,156	$39,039	$6,883	21.4
Wood ashes:				
Quantity....bushels..	....	17,083	....	....
Value....	....	$2,050	....	....

BLEACHING MATERIALS.

The class of bleaching materials includes, among a great many other chemicals, potassium bisulphite. The following table gives the quantity and value of bisulphites manufactured in the United States at the censuses of 1900 and 1905, with the amount and percentage of increase, the figures for the census of 1910 not being available. Potassium bisulphite forms a very small part of the total.

Sodium, potassium, calcium, and other bisulphites manufactured in the United States, 1900 and 1905.

	1900	1905	Increase.	Per cent of increase.
Quantity....tons..	1,461	6,223	4,762	325.9
Value....	$34,486	$110,155	$75,669	219.4

CHEMICALS PRODUCED BY THE AID OF ELECTRICITY.

Among the chemicals produced by the aid of electricity are potassium chlorate and potassium hydroxide. The following table gives the quantity and value of the potassium salts made electrolytically at the censuses of 1900 and 1905, with the amount and percentage of increase, the figures for 1910 not being available:

Potash salts made electrolytically in the United States, 1900 and 1905.

	1900.	1905.	Increase.	Per cent of increase.
Quantity....tons..	1,900	3,908	2,008	105.7
Value....	$80,097	$200,008	$119,911	149.7

DYESTUFFS.

Potash salts enter into the dyeing industry chiefly in the form of alum. The production of alum has already been given and will not be repeated here. Potassium sulphide and soda or potash lye or nitric acid are frequently used to improve the "fire" in vermilion. Potassium bichromate is extensively used in the manufacture of chrome green.

EXPLOSIVES.

Potash salts in the form of nitrate enter into the manufacture of gunpowder. The term "gunpowder" generally includes the nitrate-sulphur-charcoal combination used in blasting as well as that used in guns, and for the last 50 years it has included the blasting powder made with nitrate of soda as well as that made with nitrate of potash. Potassium nitrate is also a constituent of some of the higher-grade explosives tested and listed by the Bureau of Mines as "permissible explosives." Potassium nitrate is made by the double decomposition of sodium nitrate with potassium chloride, the former being largely imported from Chile. The reaction ($NaNO_3 + KCl = NaCl + KNO_3$) is very simple. The following table gives the quantity and cost of nitrate of potash used in the explosives industry in the United States in the years 1900 and 1905, the figures for 1910 not being available:

Potassium nitrate used in the manufacture of explosives in the United States, 1900 and 1905.

1900		1905	
Quantity.	Value.	Quantity.	Value.
Tons. 3,315	$270,186	*Tons.* 4,114	$308,644

GENERAL CHEMICALS.

Under the heading of general chemicals potash enters into the composition of a host of substances. Some of these are arsenite of potassium, used in the dyeing industry; bromide of potassium, used in photography and medicine; chlorate of potassium, used in fireworks, matches, and aniline colors; chromate of potassium, used in dyeing and electricity; manganate and permanganate of potassium, used in dyeing and bleaching, in disinfectants, and in medicine; silicate of potassium, used in making ordinary yellow soaps, as a fixative for pigments in calico printing, as a vehicle for pigments in fresco painting, for rendering cloth and paper noninflammable, etc.; cream of tartar; and argols.

THE DEPOSIT OF POTASH SALTS NEAR STASSFURT, GERMANY.[1]

DISCOVERY.

Although potash occurs in many forms and places in the United States, as described in a subsequent part of this report, up to the middle of the nineteenth century wood ashes constituted practically the sole source of supply. In 1857 a shaft which the German Government had been sinking for about five years near Stassfurt reached a depth of approximately 1,100 feet, but in the meanwhile had passed through a deposit of so-called "Abraumsalze," or refuse salts, consisting largely of compounds of potash and magnesia, then considered worthless.[2] This deposit is now and long has been the chief source

[1] Largely compiled or quoted from Clarke, F. W., Bull. U. S. Geol. Survey No. 330, 1908, pp. 176 et seq.
[2] Potash in agriculture, The German Kali Works, p. 5.

of potash and the potassium salts of commerce. It is estimated by C. Ochsenius[1] that the German deposit of potash salts may last over 600,000 years.

THEORY OF OCCURRENCE.

The theory developed by Ochsenius for the occurrence of salts at Stassfurt is briefly as follows: A deep bay is imagined, connected with the sea by a narrow and shallow channel, but otherwise cut off from oceanic circulation by a bar. If no large streams enter the bay, the outflow from it will be small, but sea water can enter freely to offset the losses due to evaporation. Evaporation of course takes place only at the surface, and the upper layers, thus becoming denser, must sink, producing a saline concentration at the bottom. In this manner, being continually supplied with new material from without, the salinity of the bay will gradually increase until saturation is reached and the deposition of salts begins. So long as salt water can enter the bay this process will continue, and the depths of the basin will in time become a solid mass of salt, covered with a sheet of bittern. If, meanwhile, an elevation of the land takes place separating the bay completely from the ocean, evaporation may proceed to its limit and the mother liquor, containing the more soluble salts, including the potash salts, will deposit its contents in more or less well-defined layers above the salt at the bottom. In the Karaboghaz and other bays on the eastern shore of the Caspian Sea the process of saline concentration can now be observed in actual operation, but only part of the program has yet been performed.

This theory of Ochsenius is not the only one possible to account for the concentration of salts. It must be remembered that salt is not deposited from sea water until it has been concentrated to about one-tenth of its original volume. Suppose, now, a large sheet of water, in whose bottom there is a deep depression, be cut off from the ocean by any change in the level of the land. The water in the depression will gradually become concentrated and its saline load will tend to accumulate there. A layer of salt will thus form of much greater thickness than if evaporation took place over a comparatively level bottom, and if the surface area of the depression is small in comparison with that of the original sheet of water the depth of the deposit may be very great. Such a deposit might also be reinforced by leaching from other salt beds or from diffused salts in adjacent areas—a process which is now going on in the valley of the Dead Sea and in certain lakes of the arid region of the western part of the United States.

SALTS DEPOSITED.

In the Stassfurt or, more properly, the Magdeburg-Halberstadt region the order of deposits, from the surface downward, is as follows:

1. Drift, about 8 meters (26 feet) thick.
2. Shales, sandstones, and unconsolidated clays of varying thickness.
3. Younger rock salt, thickness very variable, sometimes missing.
4. Anhydrite, rarely lacking, 30 to 80 meters (98 to 262 feet) thick.
5. Salt clay, average thickness 5 to 10 meters (16 to 33 feet), very rarely absent.
6. The carnallite zone, from 15 to 40 meters (49 to 131 feet) thick. At Douglashall a layer of rock salt intervenes between the carnallite and the clay. In parts of the field kainite overlies the carnallite, is itself overlain by "sylvinite" or "hartsalz," and that in turn by schoenite. These subzones are often missing.

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[1] Die Kunstdunger Industrie, vol. 11, No. 9.

7. The kieserite zone.
8. The polyhalite zone.
9. Older rock salt and anhydrite. Nos. 7, 8, and 9 have a total thickness ranging from 150 to perhaps 1,000 meters (492 to 3,280 feet). The anhydrite forms layers, averaging 7 millimeters (0.27 inch) thick, separating the salt into sheets of 8 or 9 millimeters (0.31 or 0.35 inch). These layers have been interpreted as annual deposits, due possibly to seasonal variations in temperature or to alternating drought and rain. If this supposition is correct, a Stassfurt salt bed 900 meters (2,953 feet) thick would require 10,000 years to form.
10. Anhydrite and gypsum.

The above is a complete record of the saline deposition at Stassfurt, ranging from the calcium sulphate at the bottom to the mother liquor or carnallite salts at the top. Above the carnallite a protecting layer of clay was laid down, and after that probably a new accession of sea water began the formation of a second series of beds, which, however, are regarded by some as having resulted from the re-solution and redeposition of older beds.

In the Stassfurt deposits more than 30 saline minerals have been found, some of which are regarded as primary and others as derived from the primary minerals by secondary reactions. A few are simple salts but the bulk are double compounds. Chlorides, sulphates, and borates are most common, but the mineral kainite contains both the chloride and sulphate radicles. The sulphates found at Stassfurt are as follows:

Anhydrite	$CaSO_4$.
Gypsum	$CaSO_4.2H_2O$.
Glauberite	$CaSO_4.Na_2SO_4$.
Polyhalite	$2CaSO_4.MgSO_4.K_2SO_4.2H_2O$.
Krugite	$4CaSO_4.MgSO_4.K_2SO_4.2H_2O$.
Kieserite	$MgSO_4.H_2O$.
Epsomite	$MgSO_4.7H_2O$ (reichardtite).
Vanthoffite	$MgSO_4.3Na_2SO_4$.
Bloedite	$MgSO_4.Na_2SO_4.4H_2O$ (astrakanite).
Loewite	$MgSO_4.Na_2SO_4.2\frac{1}{2}H_2O$.
Langbeinite	$2MgSO_4.K_2SO_4$.
Leonite	$MgSO_4.K_2SO_4.4H_2O$.
Picromerite	$MgSO_4.K_2SO_4.6H_2O$ (schoenite).
Aphthitalite	$K_3Na\ (SO_4)_2$ (glaserite).
Kainite	$MgSO_4.KCl.3H_2O$.

Little is heard of these salts, except of kainite and kieserite, and the former is of great importance. It is readily soluble in water, and, most of its potash being immediately available as plant food, it is used extensively as a fertilizer.

The chlorides found in the Stassfurt region are as follows:

Halite or rock salt	NaCl.
Sylvite[1]	KCl.
Douglasite	$K_2FeCl_4.2H_2O$.
Carnallite	$KMgCl_3.6H_2O$.
Tachhydrite	$2MgCl_2.CaCl_2.12H_2O=3(RCl_2.4H_2O)$.
Bischofite	$MgCl_2.6H_2O$.
Rinneite	$FeCl_2.3KCl.NaCl$.

As already stated these chlorides represent the concentration of the mother liquors in the carnallite zone. They were the most soluble compounds existing potentially in the sea water, and with the kainite ($MgSO_4.KCl.3H_2O$) they were among the last substances to crystallize. The chemistry of the deposition and the interreaction

[1] "Sylvinite" is a mixture of sylvite and rock salt; "Hartsalz" contains these substances together with kieserite.

of these substances is most complex, and the literature, mostly in German, is widely scattered.

It must not be supposed that these zones of deposition are regularly and completely separated, nor even that they represent in any close degree the products observed in the artificial evaporation of sea water or brine. In the latter case a moderate quantity of water is concentrated by itself; at Stassfurt more water was continually added from the ocean. On the one hand, calcium sulphate is deposited almost wholly at one time; on the other, new quantities were precipitated so long as the evaporating bay retained its connection with the sea. In the salt pan gypsum ($CaSO_4.2H_2O$) forms a bottom layer before salt begins to separate out; at Stassfurt anhydrite ($CaSO_4$) is found in greater or less amount through all the zones, and so also is salt (NaCl). When a shallow lake or isolated lagoon evaporates, the artificial process is closely paralleled, but a concentration, with continuous replenishment, lasting for thousands of years, is a very different thing. The principles are unchanged, the broad outlines remain the same, but the details of the process are greatly modified.

GERMAN POTASH SALTS IN THE UNITED STATES.

According to Consul General A. M. Thackara, of Berlin,[1] the American consumption of German potash in various forms embraces more than half of the exported material and nearly 18 per cent of the entire production. But while the great bulk of the potash salts consumed in the United States comes from Germany, that country, on the other hand, is dependent on the United States for a large part of the mineral phosphates it uses.

According to the latest report of the German potash syndicate, the following are the quantities of several potash salts which were handled by its members and exported to the United States in 1908:

Muriate of potash (chloride of potassium or "Chlorkalium") at 80 per cent, 288,524 metric tons,[2] of which 105,281 tons were consumed in Germany, 104,048 tons were exported to the United States, and the remainder to other foreign countries. The amount exported to the United States therefore was 36 per cent of the total.

Fertilizer at 80 per cent (muriate of potash), 21,268 metric tons, all of which was exported to Scandinavia and Denmark.

Sulphate of potash (Schwefelsaureskali) at 70 per cent, 54,751 metric tons, of which Germany used 2,821 tons, the United States 26,000 tons (47 per cent), England 4,986 tons, and France 6,110 tons, the remainder being sent to other foreign countries.

Calcined sulphate of potassium and magnesium (double manure salts) at 48 per cent, 33,756 metric tons, of which 16,928 tons, or 50 per cent, were sold to the United States and 15,124 tons to Holland, the remainder being consumed in Germany and other countries.

Crystallized sulphate of potassium at 40 per cent, 665 metric tons, all of which was used in Germany.

Manure salts with 20 per cent, 30 per cent, and 40 per cent K_2O, 284,989 metric tons, of which Germany consumed 171,016 tons, the United States 52,731 tons (19 per cent), Scandinavia and Denmark 24,005 tons, and other countries the remainder.

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[1] Daily Consular and Trade Report No. 3587, Sept. 18, 1909.
[2] A metric ton is equivalent to 2,204.6 pounds.

Calcined kieserite, 668 metric tons, of which 542 tons were used in Germany and the remainder in various other countries.

Kieserite in blocks, 25,532 metric tons, of which 20,950 tons were consumed in Germany, 2,794 tons (11 per cent) in the United States, and 1,788 tons in all other countries.

Kainite and sylvinite, 2,388,381 metric tons, of which Germany consumed 1,613,556 tons, the United States 361,322 tons (15 per cent), and other countries 413,503 tons.

Carnallite and "berg-kieserite," 74,385 metric tons, of which 71,403 tons were used in Germany and the remainder exported.

In the following tabulated statement, compiled from official statistics, are shown the production of potash salts in Germany during 1907 and 1908, the value of the products, and the average value per ton:

Production and value of potash salts in Germany, 1907 and 1908.

	1907			1908		
	Quantity (metric tons).	Value.	Average value per ton.	Quantity (metric tons).	Value.	Average value per ton.
Kainite	2,624,412	$8,595,846	$3.27	2,589,804	$8,812,426	$3.40
Other potash salts	3,124,956	7,265,426	2.33	3,500,635	8,064,630	2.30
Muriate of potash [1]	473,138	12,639,704	26.72	508,622	13,387,738	26.32
Sulphate of potassium	60,292	2,217,922	36.79	55,755	2,037,994	36.55
Sulphate of potassium and magnesium	33,368	631,652	18.92	33,149	663,068	20.00

[1] Including 117,390 tons of manure salts, worth $1,843,786, in 1908, and 83,763 tons of manure salts, worth $1,193,332, in 1907.

FINANCIAL RESULTS OF GERMAN POTASH MINING.

The following statement shows the results of the operations of 21 German potash mines in 1906:

Operations of 21 German potash mines, 1906.

	Capital stock or paid-up assessments.	Amortization and general reserve.	Net profits.	Dividends paid.	Per cent of capital.
Westeregeln	$1,999,200	$280,592	$415,376	$299,880	15.0
Aschersleben	2,856,000	189,320	307,805	285,600	10.0
Wilhelmshall	440,300	192,067	314,738	285,600	64.8
Glückauf	476,000	112,039	192,067	285,600	60.0
Hedwigsburg	190,400	82,739	223,322	199,920	105.0
Burbach	723,520	70,770	276,541	190,400	25.9
Salzdetfurth	1,666,000	142,819	277,358	233,240	14.0
Hohenfels	1,063,860	108,452	200,799	171,360	68.1
Rossleben	1,439,900	102,114	150,597	142,800	9.9
Carlsfund	1,142,400	86,215	181,921	154,700	13.5
Hohenzollern	1,142,400	58,991	119,000	119,000	10.4
Justus	1,190,000	83,468	16,639	47,600	4.0
Kaiseroda	690,200	84,951	147,560	142,800	20.7
Beienrode	1,011,500	48,777	142,800	142,800	14.1
Jessenitz	1,190,000	110,466	118,626	95,200	8.0
Wintershall	1,094,800	116,411	147,941	147,941	13.5
Sigmundshall	476,000	28,485	23,555	21,718	5.0
Einigkeit	1,568,865	83,439	118,413	....	....
Alexandershall	761,280	132,248	216,821	142,800	18.7
Thiedershall	952,000	79,462	84,110	66,640	7.0
Johanneshall	1,428,000	73,331	71,581	....	....
Total	23,502,625	2,267,156	3,747,570	3,175,599	....

The above statement shows that the 21 mines earned in 1906 an average profit of 15.9 per cent on the invested capital and declared an average dividend of 13.5 per cent. It can be safely assumed that the works not included in this statement also reached this average, as among them were a number of the most profitable mines and but few of the minor companies.

In discussing the position of the potash industry, as developed by the late potash syndicate, Thackara's report, already cited, gives some interesting information as to the cost of production of the different grades of potash salts, based on expert opinion, it being impracticable, for several reasons, to give the official figures. The following statement shows the cost of production and the foreign and domestic prices of the several grades per metric ton:

Cost of production and prices of potash salts.

	Cost of production per metric ton.	Price per metric ton.	
		Foreign.	Domestic.
Kainite	\$1.547 to \$1.904	\$4.05 to \$4.52	\$3.38
Muriate of potash	11.90 to 17.85	33.80	33.80
Sulphate of potash	16.66 to 26.18	39.20	39.20
Manure salts	8.33 to 11.90	15.20	15.20

Except for the 40 per cent manure salts, the costs of producing which are higher, in consequence of the small output, the costs of production of the salts listed above vary between 40 and 60 per cent of the receipts from sales. These figures are based on the normal running time of the works in 1906. In the two years 1907 and 1908 the costs of production somewhat increased. They may at some plants even have passed the maximum of 60 per cent. The costs are still low, however, when compared to those of other mining industries. In coal mining, for example, the costs of production amount to 70 or 80 per cent of the total receipts and are often even greater. These facts explain how the selling policy of the potash syndicate and the comparatively low costs of production have stimulated the establishment of new plants.

OCCURRENCE OF POTASH SALT IN THE UNITED STATES.

IGNEOUS ROCKS.

Potash is abundant as a constituent of the rocks which form the crust of the earth. According to F. W. Clarke[1] the percentage of potash (K_2O) in the earth's crust is 3.00, this result being an average of 1,434 determinations made in the laboratories of the United States Geological Survey up to January 1, 1908. In some varieties of igneous rocks, particularly those rich in the potash feldspars, there is a large amount of potentially valuable potash. The feldspars are widely distributed minerals and comprise about 60 per cent of the earth's crust. Among the igneous rocks containing large amounts of potash are the glasses, of which the chief are obsidian, pumice, perlite, and pitchstone. In these rocks the potash may run as high as 5 or 6 per cent. The rhyolites are also rich in potash. Examples of this rock containing more than 5 per cent of potash are common

[1] Bull. U. S. Geol. Survey No. 419, 1910, p. 77.

and a certain rhyolite from Silver Cliff, Colo., has been shown to contain 8.38 per cent.[1]

The trachytes and phonolites are also rich in potash, consisting chiefly of that variety of potash feldspar (orthoclase) known as sanidine. Some of the trachytes are known to contain nearly 8 per cent of potash. Among the granitoid rocks should be mentioned granite, monzonite, and syenite, which contain considerable amounts of the potash feldspars. The leucite rocks of the Leucite Hills, Wyoming, contain, so far as known, the largest amount of potash among the igneous rocks. These rocks have been described by Whitman Cross, of the United States Geological Survey.[2] Certain of them, wyomingite and orendite, contain from 9.81 to 11.91 per cent of potash (K_2O). In many localities there occur large dikes or deposits of more or less pure feldspar, commonly orthoclase, which run much higher in potash than the ordinary granite rocks and may approach the theoretical potash content of pure orthoclase feldspar—16.8 per cent of potash. Such deposits have been developed in the New England States, Pennsylvania, New York, and Maryland, where they have been mined extensively and the feldspar ground to fine powder, principally for use in pottery manufacture. These deposits may constitute in themselves a comparatively high-grade fertilizer were the potash all available for plant food. As the feldspar for use in pottery making must be almost entirely free from mica or iron-bearing minerals, large quantities of such potash-rich material are rejected at every quarry. But the potash of these rocks, even when finely ground, is tightly locked up, being practically insoluble by any known cheap commercial process. Ten, eight, or even five per cent potash rock, of which there are millions of tons well distrib uted over the globe, would be highly valuable as a fertilizer were there any known cheap method of making the potash available for immediate use to the growing plant.

Experiments have been made by the United States Department of Agriculture [3] for the utilization of this potash supply through fine grinding or pulverizing the feldspathic rocks in a manner similar to the grinding for pottery. So far as known these experiments have not been completed and the results thus far attained have not proved conclusive. This source of potash has also been investigated by individuals, among whom may be mentioned Dr. A. S. Cushman, formerly assistant director of the Office of Public Roads, who, on April 30, 1907, took out patent No. 851922 for a process for the extraction of potash, soda, and other soluble bases from ground rocks. This patent is described as follows: [4]

Feldspathic or other potash-bearing rock is ground to fine powder, slimed with water, and placed inside of a suitable wooden container, which is then set inside of another larger vessel. Water is now placed in the outer vessel and electrodes inserted so that the inner or slime chamber becomes connected with the positive pole and the outer chamber with the negative pole. A current of electricity from a dynamo is then turned on. When this is done the potash, soda, and other soluble bases are partially set free from the combinations with alumina and silica in which they exist in the feldspathic rocks.

Under the influence of electrolysis the soluble bases pass through the wooden partition and the water in the outer vessel becomes alkaline, owing to the accumulation of potassium and sodium hydroxide. The electrical resistance of the cells arranged in

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[1] Cross, Whitman, Proc. Colorado Sci. Soc., Dec. 5, 1887, p. 229.
[2] Am. Jour. Sci. 4th ser., vol. 4, 1897, p. 130.
[3] U. S. Dept. Agr., Bur. Plant Industry, Bull. 104, 1907.
[4] Chem. Engineer, vol. 5, 1907, p. 21; Bur. Census, Bull. 92, 1908, p. 39.

this way is so high that only a small fraction of an ampere passes through under a potential of 110 volts. After a certain percentage of the alkali has been extracted in this manner, the action slows down, and it has been found necessary to devise methods to accelerate it.

Dr. Cushman has discovered two methods of accelerating the decomposition of the rock slime and hastening the extraction of the potash. (*a*) By a suitable grinding or churning arrangement the slime in the inner chamber can be kept in a continual agitation, which causes the necessary reactions to go on more rapidly. (*b*) If a small quantity of hydrofluoric acid is added to the slime a very great acceleration in the rate of decomposition and extraction is obtained, and it is possible in a reasonably short time to make a complete extraction of all the potash contained.

If instead of caustic potash it is desired to make various salts of potash such as are in ordinary use for fertilizers and other purposes—that is, nitrate, sulphate, chloride, and phosphate—the corresponding acids (nitric, sulphuric, hydrochloric, and phosphoric) are fed in a dilute form into the outer or so-called cathode chamber fast enough to neutralize the caustic alkali as it forms. By varying the amount of acid added the resistance of the cell can be controlled and the decomposition of the rock carried on under the best and most economic conditions.

Dr. Cushman has recently patented another process for the extraction of potash from rocks, in the form of a water-soluble salt or salts (patent No. 987436, dated March 21, 1911). In this process the potash-bearing rock is subdivided as finely as possible, preferably so fine that it will pass through a 200-mesh screen. The powder is then mixed with a suitable amount of finely pulverized quicklime, 20 parts of lime to 100 parts of rock being a proper proportion. The mixture is then spread on a belt or drum conveyor in a layer three-eighths to half an inch thick. A solution of calcium chloride is then applied in separate drops so that the aggregates formed shall not merge. The calcium chloride reacts with the lime, forming an oxychloride cement, and the clumps or aggregates which form on its addition harden very quickly and are separated from the rest of the mass by screening. They are then heated to a high temperature in a rotary furnace or kiln, when potassium chloride is formed. The product when discharged from the furnace in the form of lumps or small particles may then be ground or crushed as a fertilizer or as a component of mixed fertilizers, or the potassium chloride may be extracted with water and obtained by evaporation in the form of the salt.

GREENSAND MARLS OF NEW JERSEY.

Potash is found in river waters, but in smaller quantities than soda (Na_2O). The difference is still greater in ocean water, owing to the fact that the potash for some unknown reason is largely taken up by the sediments, forming glauconite, while the soda is largely held back in solution. This glauconite is an important constituent of the greensand marls of New Jersey.

About 30 years ago the greensand marls of the southern portion of New Jersey were in great demand. On the first geologic map of that State the location of the marl beds was shown, and in some of the earlier reports the deposits were described and numerous analyses given, as well as instructions in the use of the marl. In recent years, however, marl has been supplanted to a large extent by the more highly concentrated artificial fertilizers and is no longer dug extensively.

The following analyses show the composition of the different grades of marl as dug and applied to the soil. The glauconite or greensand in them is of nearly uniform composition, but mixed with it are carbonate, sulphate, and phosphate of lime, quartz sand, sulphide and phosphate of iron, shells, etc. The differences in the kind and quantity of these substances cause wide differences in the appearance of the marl containing them, as well as in its composition and properties.

The following table gives the potash and phosphoric acid content, in percentages, of typical specimens of New Jersey marl:

Potash and phosphoric acid in typical greensand marl of New Jersey.

	1	2	3	4	5	6	7	8	9	10
Phosphoric acid	1.14	1.33	1.02	2.24	2.69	2.56	3.58	3.87	2.58	2.30
Potash	3.65	5.67	6.32	5.18	6.31	4.62	3.75	4.11	4.25	3.53

New Jersey marl[1] has been of incalculable value to the region in which it is found. It has raised this region from the lowest stage of agricultural exhaustion to a high state of improvement. Found in places where no capital and but little labor were needed to get it, the poorest people have been able to avail themselves of its benefits. Lands which in the old style of cultivation had to lie fallow, by the use of marl produce heavy crops of clover and grow rich while resting. Land which had been worn out and left in common are now by the use of this fertilizer yielding large crops of the finest quality. Everywhere in the marl district may be seen farms which in former years would not support a family but which are now making their owners rich through their productiveness. Bare sands by the application of marl are made to grow clover and then crops of corn, potatoes, and wheat. "Pine barrens" by the use of marl are made into fruitful land. The price of land in the greensand-marl belt of New Jersey was considerably below that in the northern part of the State 40 years ago; now that the lands are improved their price is higher than that of lands in the northern part of the State.

A recent invention[2] proposes to use glauconite or greensand (such as is found in New Jersey) as a principal ingredient in the manufacture of hydraulic cement. In making the cement the potash of the greensand would be volatilized at the temperatures employed and its recovery as a by-product would be possible.

SALINES.

The known occurrences of potash salts in the United States are few in number. Those which are known and which promise results are confined to certain arid portions of the Western States. Here the structural conditions are favorable for the retention of any salines that may have been deposited, and the presence of alkaline lakes suggests the possibility that others may once have existed and are now covered by later deposits, their saline content being concealed. Though potash salts occur in this region in the waters of the alkaline lakes, it has yet to be proved that these waters contain a commercially valuable quantity of potash salts. An idea of the quantity of potash salts in the waters of some of these lakes may be obtained from the figures given in the following pages.[3] Though the waters of these lakes have never been utilized for their content in potash, it appears as if they would prove of some commercial value. It must be admit-

[1] From Ann. Rept. State Geologist of New Jersey, 1886.
[2] Patent 912266, dated February 9, 1909.
[3] Chatard, T. M., Bull. U. S. Geol. Survey No. 60, 1890, pp. 27-101. Bailey, Gilbert, Bull. California State Min. Bur. No. 24, 1902, pp. 94 et seq.

ted, however, that the German deposits are unique, not so much in the quality of the salts contained in them as in the quantity and in the fact that the overlying geologic formations are such that they have been kept intact so far as known, a condition which is as important as the deposition of the original material itself.

Potash salts occur in the water of Owens Lake, Inyo County, Cal. This lake at the present time has no outlet, and on the completion of the Los Angeles aqueduct will be deprived of the greater part of the drainage hitherto tributary to it. Its ancient shore line, nearly 200 feet above its present level, indicates that at one time it had an outlet to the south and was there joined to a chain of lakes. Its waters are strongly alkaline and the principal salts contained in them are the chloride and carbonate of sodium. A number of analyses, more or less complete, have been made of its water. These vary according to the conditions under which the samples were collected and the analyses made. The dilution of the water of this lake after storms in the surrounding mountains and its concentration at the end of summer explain in part differences in the analyses. One of the first analyses of water from this lake is as follows:

Analysis of water of Owens Lake.

	Grains per imperial gallon.
Sodium chloride	2,942.15
Sodium sulphate	956.80
Sodium carbonate	2,914.43
Potassium sulphate	35.74
Potassium silicate	139.54
Organic matter	16.95

The following analyses are comparatively recent:

Analyses of water of Owens Lake.

[Grams per liter.]

	1	2
Silica	0.220	0.1721
Iron and aluminum oxides	.038	
Calcium and magnesium carbonates	.055	
Sodium borate ($Na_4B_4O_7$)	.475	
Potassium chloride	3.137	
Sodium chloride	29.415	23.2830
Sodium sulphate	11.080	9.2907
Sodium carbonate	26.963	24.4080
Sodium bicarbonate	5.715	
Potassium sulphate		6.4487
Total	77.098	63.6025

1. T. M. Chatard, analyst, Bull. U. S. Geol. Survey No. 60, 1890, p. 58.
2. Oscar Loew, analyst. Ann. Rept. Geog. Surveys W. 100th Mer., 1876, p. 190.

Analysis No. 1 gives the following composition of the dried salts:

Analysis of dried salts from Owens Lake.

	Per cent.
Silica	0.28
Iron, alumina, lime, magnesia	.13
Sodium biborate (borax)	.63
Potassium chloride	4.07
Sodium chloride (salt)	38.16
Sodium sulphate	14.38
Sodium carbonate	34.95
Sodium bicarbonate	7.40
	100.00

The waters of this lake also contain a small quantity of lithia, ›hosphates, and nitrates. The specific gravity of the water is 1.051.

Analyses of the crude soda formed by solar evaporation of the vater of this lake gave Chatard the following results:

Analyses of soda from evaporation of water of Owens Lake.[a]

	1	2	3	4	5	6
Vater	20.87	14.51	4.33	3.43	2.24	11.03
nsoluble	1.55	.078	......	......	......	......
)rganic matter, silica, alumina, and lime and magnesium carbonates	.37	.237	.09	.06	.06	.18
'otassium chloride	.51	1.07	1.12	1.14	1.21	2.93
odium chloride	3.51	7.44	35.06	45.59	60.99	19.16
odium sulphate	1.89	3.18	25.44	26.70	19.01	5.70
odium carbonate	40.87	43.75	22.84	18.19	12.51	55.04
odium bicarbonate	30.65	30.12	10.53	4.06	3.88	4.09
odium biborate	......	......	......	......	......	2.01
	100.22	100.385	99.41	99.17	99.90	100.14

[a] Bull. U. S. Geol. Survey No. 60, 1890, p. 63.

From these analyses and from data similar to those given beyond n connection with Mono Lake it is estimated that Owens Lake conains, among other constituents, 8,000,000 tons of potassium sul›hate, together with large quantities of sodium carbonate, common alt, and borax. These materials are, however, present in such dilute olution that they have not been utilized up to the present time. The diversion of Owens River, however, must gradually result in a ıotable increase in the alkalinity of Owens Lake and the conditions or the utilization of the potash salts will become more favorable.

At Owens Lake the manufacture of sodium carbonate has been arried out on a commercial scale. In order to determine the most avorable conditions for the process, Chatard subjected a quantity of he water to fractional crystallization and analyzed the salts which were uccessively deposited. Two concordant series of experiments were nade, together with a less complete but corroborative set with water rom Mono Lake. The results of the first group were as follows:

Analyses of salts deposited by fractional crystallization of water of Owens Lake.[a]

A. The natural water of Owens Lake. Specific gravity, 1.062 at 25°. Salinity, 77.098 grams per liter.
B. First crop of crystals. Water concentrated to one-fifth its original volume. Specific gravity of mother iquor, 1.312 at 27.9°.
C. Second crop of crystals. Specific gravity of mother liquor, 1.312 at 25°.
D. Third crop of crystals. Specific gravity of mother liquor, 1.315 at 26.25°.
E. Fourth crop of crystals. Specific gravity of mother liquor, 1.327 at 35.75°.
F. Fifth crop of crystals. Specific gravity of mother liquor, 1.300 at 13.9°. This crop was obtained by hilling the solution in order to determine the effect of cold.

	A.[b]	B.	C.	D.	E.	F.
I_2O	......	14.51	4.33	3.43	2.24	11.03
Ia_2CO_3	34.95	43.75	22.84	18.19	12.51	55.04
$IaHCO_3$	7.40	30.12	10.53	4.06	3.88	4.09
Ia_2SO_4	14.38	3.18	25.44	26.70	19.01	5.70
$IaCl$	38.16	7.44	35.06	45.59	60.99	19.16
$Ia_2B_4O_7$	.63					
$IaBO_2$	......	......	......	......	......	c2.01
CCl	4.07	1.07	1.12	1.14	1.21	2.93
$CaMg)CO_3$	.08	.14			......	......
$AlFe)_2O_3$	.05	.01	.09	.06	.01	.02
iO_2	.28	.055			.05	.16
)rganic matter	......	.032			......	......
nsoluble	......	.078	......	......	......	......
	100.00	100.385	99.41	99.17	99.90	100.14

[a] Clarke, F. W., Bull. U. S. Geol. Survey No. 330, 1908, p. 192.
[b] Composition of the anhydrous residue.
[c] Chatard supposes that the biborate could not exist in so strongly alkaline a solution as the mother iquor from which this crop was obtained.

Mono Lake is situated in Mono County, Cal., near the Nevada line, at an elevation of 6,730 feet, the highest level above the ocean of all the saline lakes of the Great Basin. Its water is dense and alkaline. At this lake the alkaline carbonates are abundant, owing to the volcanic rocks of the lake basin, as shown by the complete analysis made by T. M. Chatard, as follows:

Analysis of water of Mono Lake.

	Grams per liter.
Silica	0.0700
Calcium bicarbonate	.0810
Magnesium bicarbonate	.3349
Potassium chloride	1.8342
Sodium chloride	18.5068
Sodium sulphate	9.8690
Sodium carbonate	18.6720
Sodium bicarbonate	3.9015
Sodium biborate	.2000
Alumina	.0030
	53.4724

The results of this analysis show that chloride of sodium and carbonate of sodium constitute nearly 35 per cent each of the total solids. Experiments by Chatard on the fractional crystallization of the mineral content of the water gave the results presented below, which show the same general rule of deposition as at Owens Lake. The water used in the experiments had already been evaporated to about one-sixth of its original volume and had a specific gravity of 1.210. The analyses are as follows:

Analyses of salts deposited by fractional crystallization of water of Mono Lake.

	1	2	3	4	5
Water	12.28	10.98	0.69	4.18	11.31
Silica	.07	.17	.16	....	.13
Calcium carbonate	.05	.14	.05	.07	.02
Magnesium carbonate	.48	.46	.02	....	....
Potassium chloride	.69	.69	.47	.71	15.20
Sodium chloride	19.18	21.34	29.96	60.75	32.36
Sodium sulphate	2.73	14.18	49.13	16.22	6.65
Sodium carbonate	36.87	41.07	18.27	14.22	33.69
Sodium bicarbonate	27.37	10.99	10.03	3.88	.49
	99.72	100.02	99.78	100.03	99.85

The lake has an area of 85.5 square miles and an average depth of 61.5 feet. From these figures its volume has been calculated. From its volume and the mineral content of its water the amount of the various salines which it contains has been estimated. The results, which are of interest, indicate the presence in the lake of 10,538,100 tons of potassium chloride. Such figures show that the saline reserves in this and other incompletely evaporated or playa lakes of the desert regions of California and other public-land States are very large and may prove valuable when transportation facilities have been developed and methods for the extraction of the salts perfected. Potassium nitrate has been found in the desert region northeast of Salton, Riverside County, Cal.

ALUNITE.

Near the close of the year 1910 Mr. A. E. Custer, of Salt Lake City, Utah, sent to the United States Geological Survey a specimen of alunite (hydrous sulphate of potash and aluminum, $K_2O.3Al_2O_3.4SO_3.6H_2O$) of a very unusual type. The occurrence is reported to be located near Richfield, Sevier County, Utah, close to the railroad. The deposit varies from 6 to 10 feet in thickness.

An occurrence of scientific and economic interest is the association of alunite and gold in the Goldfield district of Nevada. F. L. Ransome,[1] of the United States Geological Survey, believes that the composition of the ores and the changes exhibited in the country rock point to hot ascending solutions as the agent which has produced the alunite. On some of the ore dumps the partly soluble sulphate is present in sufficient quantity to suggest its removal by leaching. Before undertaking such a step several factors must be considered, such as quantity of raw material, proximity to market, transportation facilities, and freight rates.

POSSIBLE OCCURRENCE OF POTASH SALTS IN THE UNITED STATES.

To make a thorough and complete investigation of the occurrence of potash salts in the United States, every known salt deposit should be tested, for ordinary rock salt may overlie soluble potash salts as well as underlie them. Both these conditions exist at Stassfurt. The normal occurrence of salt is, however, at the base of a series of soluble salines deposited from the evaporation of sea water. The brines of Midland and Isabella counties, Mich., are of interest in this connection, inasmuch as they contain bromine in commercial quantity, a fact which indicates partial desiccation of sea water and the occurrence of mother liquors. The salt deposits of Mason County, W. Va., and adjacent parts of Ohio likewise contain and are worked for bromine, as are also the brines of Kanawha County, W. Va., and certain of those near Pittsburgh, Pa.

The red beds of the southwestern part of the United States, in Texas, Oklahoma, Kansas, Colorado, New Mexico, and possibly other States, contain deposits of gypsum and salt and are worth notice as possible sources of potash salts. These beds might profitably be explored in those places where structural conditions seem to favor the accumulation and retention of the salines.

ORGANIC SOURCES OF POTASH SALT.[2]

The organic sources of potash salts are wood ashes, beet-sugar molasses and residues, wool scourings (suint), and sea weed.

WOOD ASHES.

Land plants take up considerable quantities of potassium compounds from the soil. When the plants are burned, about 10 per cent of the weight of the ash is potassium carbonate, which may be obtained by lixiviation. Potash from wood ashes is now made chiefly

[1] Econ. Geology, vol. 2, No. 7, 1907, p. 689; Prof. Paper U. S. Geol. Survey No. 66, 1909.
[2] Taken in part from Thorp, F. H., Outlines of industrial chemistry, 1901, pp. 130 et seq.

in Russia, Sweden, and America, the woods most employed being elm, maple, and birch. Sometimes the stumps and small branches only are burned, the trunks being used for timber. The ashes are moistened slightly, put into tanks having false bottoms on which straw is spread, and then lixiviated with warm water. The lye so obtained is evaporated (sometimes by the waste heat from the burning wood) in iron pots until it solidifies on cooling. The dirty brown mass is then calcined in a reverberatory furnace until all the organic matter is destroyed. The product is known as potash or crude pearlash. It is white or gray in color, and contains about 70 per cent of K_2CO_3, with some potassium sulphate, potassium chloride, and sodium salts. By redissolving the crude potash in water and settling and concentrating the solution until the sulphates and chlorides separate as crystals, a concentrated and fairly pure lye is obtained. When this is evaporated to dryness and the residue calcined, it yields a much purer product, known as refined pearlash, containing from 95 to 97 per cent of K_2CO_3. It is necessary that low heat be employed in the calcination, for the charge fuses at a moderate temperature.

Quicklime is often put in the bottom of the tanks before the ashes are introduced. On leaching, the solution of potassium salts reacts with the lime, forming insoluble calcium salts and yielding more or less potassium hydroxide in the lye. The resulting product is a mixture of potash and caustic potash.

BEET-SUGAR MOLASSES AND RESIDUES.

In the manufacture of beet sugar a very impure molasses remains, containing among other things a large amount of soluble potassium salts. This molasses is now generally fermented, and in that process the sugary substances are converted into alcohol, which is distilled off, leaving the mineral salts in the liquid residue, called "vinasse" or "schlempe." If this is evaporated to dryness and the mass calcined, the organic potassium salts are decomposed, leaving in the cinder about 35 per cent of potassium carbonate and a large amount of chloride and sulphate, together with sodium salts.

WOOL SCOURINGS (SUINT).

Wool scourings furnish some potash in countries where much wool is washed. Sheep's wool as it comes from the animal contains from 30 to 75 per cent of its weight in impurities, consisting of dirt, sand, dung, etc.; wool grease or "yolk," a fatlike substance, made up of cholesterine and compounds in which it is associated with oleic, stearic, and palmitic acids; and "suint," which consists chiefly of potassium salts of oleic, stearic, and other organic acids, with small quantities of chlorides and sulphates and nitrogenous matter. The "suint" exudes from the animal in the perspiration and is deposited on the wool by evaporation. It is soluble in cold water and is thus removed in the scouring process. If the wash waters containing wool grease and suint are run into streams, pollution of the water results. The desirability of preventing this nuisance, as well as the value of the potash, has resulted in attempts to dispose of the washings in some economical manner, and they are usually evaporated to dryness and calcined. When the material is calcined in closed retorts, a considerable quantity of ammonia is obtained. The cinder is then lixiviated and on evaporation the solution yields, first, chlorides and sulphates of potassium and sodium, and finally a very pure potash which averages a little less than 4 per cent of the weight of the raw wool scoured.

This mode of utilizing wool grease and suint is mainly practiced in France, Belgium, and Germany, and in these countries it is done chiefly to prevent the pollution of the streams. Cheap fuel is very essential to a successful working of the process. On a small scale it can not be carried on profitably, and the wash waters are often run onto the fields as fertilizer.

POTASH IN SEAWEEDS.

A concentration of potash salts from sea water is reported as being effected by the giant seaweeds of the California coast. These plants, on drying, are said to exude nearly pure potassium chloride, and its recovery on a commercial scale has been suggested but so far as known has not yet been actually tried. It is understood, however, that some potash is recovered from kelp elsewhere.

SALT AND BROMINE.

By W. C. Phalen.

SALT.

OCCURRENCE.

Common salt occurs solid as rock salt, and in solution both in sea water and in brine derived from springs, lakes, or wells. It is found in both these forms stored in various beds in the crust of the earth. It is obtained from all these sources in the United States.

PRODUCTION.

The production of salt in the United States in 1910 amounted to 30,305,656 barrels of 280 pounds each, valued at $7,900,344. In 1909, the production reported was 30,107,646 barrels, valued at $8,343,831, an increase in the production of 1910 amounting to 198,010 barrels, but a decrease in value of $443,487. Expressed on a tonnage basis these quantities represent an output of 4,215,070 short tons in 1909, and of 4,242,792 short tons in 1910, an increase in the latter year of 27,722 short tons. In 1909 the average net value was 27.713 cents per barrel or $1.98 per short ton; in 1910 corresponding values were 26.069 cents per barrel and $1.86 per short ton. The increase in the production was not sufficiently large to offset the effect of the slight decrease in value, which amounted to only 1.644 cents per barrel, or 12 cents per ton.

In the following table are given the quantity and value of salt produced in the United States from 1893 to 1910, inclusive:

Production and value of salt in the United States, 1893–1910.

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....	[1] 30, 107, 646	8, 343, 831
1901....do....	20, 566, 661	6, 617, 449	1910....do....	[1] 30, 305, 656	7, 900, 344

PRODUCTION BY STATES AND GRADES.

Production by grades.—The quantity of table and dairy salt produced in 1910 shows a considerable increase as compared with that of the previous year. Ordinary rock salt also shows a notable gain, as does also the output of brine used in the chemical factories and the miscellaneous production classified as "Other grades." The other

[1] Includes production of Hawaii and Porto Rico.

grade of fine salt of first quality classified as "common fine," togethe with the various grades of coarser salt known as "common coarse," "packers," and "solar," showed a decline for the year.

Salt is largely used for culinary purposes, and also in the meat-packing, fish-curing, dairying, and other industries to preserve th products from deterioration. The chlorination of gold also consume large quantities of salt. In the form of brine it is largely used in th chemical industries in the preparation of soda ash (sodium carbonate), caustic soda, and various other chemicals containing a sodiur base.

For convenience salt is classified according to the grades by whic it is sold by the producer, the grades being determined by the amoun of refining, the methods employed in refining, and the purposes fo 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 include extra fine and fancy grades prepared for family use, and all grade artificially dried, used for butter and cheese making, and such specia brands. Under "common fine" salt are included all other grades o fine salt of first quality, not artificially dried, such as those known t the trade as "C. F.," "No. 1 F," "anthracite," etc. "Commor coarse" salt includes all grades coarser than "common fine," made b artificial heat, such as "steam coarse," "No. 1 coarse," "pan solar," "G. A.," "Liverpool ground," "C. C.," etc. By "packers" salt i 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 ir 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, 1906–1910, in barrels.

Year.	Table and dairy.	Common fine.	Common coarse.	Packers.	Solar.
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
1910	3,514,748	6,153,296	2,602,737	327,304	1,223,371

Year.	Rock.	Other grades.	Brine.	Total production.	Total value.
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
1910	6,965,938	129,036	9,389,226	30,305,656	7,900,344

Production by States.—The following table gives the production and value of the salt produced in the United States from 1907 to 1910, inclusive, by States:

Production and value of salt, 1907–1910, by States, in barrels.

State.	1907		1908		1909		1910	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
New York	9,642,178	$2,335,150	a10,023,872	a$2,386,471	a10,914,255	a$2,646,736	a11,642,520	$2,585,739
Michigan	10,786,630	2,062,357	10,194,279	2,458,303	9,966,744	2,732,556	9,452,022	2,231,262
Ohio	3,851,243	979,078	3,427,478	864,710	3,684,775	993,700	3,673,850	951,963
Kansas	2,667,459	962,334	2,588,814	882,984	2,769,849	782,676	2,811,448	947,369
Louisiana	1,157,621	226,892	(b)	(b)	(b)	(b)	(b)	(b)
California	626,693	302,940	899,028	374,828	886,564	558,889	937,514	519,667
West Virginia	156,147	76,527	145,157	70,481	150,492	76,463	155,625	62,955
Texas	356,086	226,540	442,571	255,652	409,315	260,286	382,164	272,568
Utah	345,557	199,779	242,678	169,833	246,935	147,318	249,850	185,869
Hawaii	....	....	....	....	7,796	5,292	11,450	9,570
Idaho	1,600	2,040	1,114	1,413	793	1,118	885	1,127
Porto Rico	....	....	....	....	166,790	26,810	(c)	(c)
Nevada	6,457	3,654	9,714	4,785	16,107	19,847	17,535	10,600
Oklahoma	800	910	(c)	(c)	(c)	(c)	2,564	881
Other States	d 105,657	61,350	e 847,357	84,172	e 887,231	92,140	f 968,229	120,774
Total	29,704,128	7,439,551	28,822,062	7,553,632	30,107,646	8,343,831	30,305,656	7,900,344

a Includes Louisiana.
b Included in New York.
c Included in "Other States."
d Includes Pennsylvania, New Mexico, and Massachusetts.
e Includes New Mexico, Oklahoma, Pennsylvania, and Virginia.
f Includes New Mexico, Pennsylvania, and Virginia.

The six leading States in the salt industry in 1910 were New York, Michigan, Ohio, Kansas, Louisiana, and California, named in the order of their importance, based on their output of material. As regards the value of output, the States named hold the same relative rank except in the case of California and Louisiana. The value of the product of the former State exceeded that of Louisiana for reasons which will be mentioned in the consideration of the salt industry by individual States. During the two years 1908 and 1909 both the quantity and the value of Michigan salt exceeded those of New York salt, and since 1905 Michigan has been the largest producer among all the States. New York, however, in 1910 again assumed the position of the leading salt-producing State, a position which she held prior to 1905.

Production by States and grades.—The following table shows the grades of salt produced in the different States in 1910. Brine and "Other grades" are combined in order to conceal the individual production of dry salt obtained from the brine:

Production of salt in 1910, by States and grades, in barrels.

States.	Table and dairy.		Common fine.		Common coarse.		Packers.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
California	257,957	$266,566	....	....	....	....	131,750	$64,979
Hawaii	....	....	....	....	....	....	3,571	3,000
Idaho	14	38	171	$279	214	$234	....	....
Kansas	156,421	158,946	1,155,307	473,632	142,129	42,996	....	....
Michigan	798,434	565,653	2,216,181	734,823	1,992,465	596,301	92,426	43,942
Nevada	714	1,500	5,714	1,600	178	200	....	....
New York	1,258,086	605,878	1,322,014	383,940	231,971	77,880	49,914	15,225
Ohio	885,300	478,426	976,486	298,893	217,321	69,581	49,643	20,288
Oklahoma	1,071	113	179	250	....	....	....	....
Texas	93,243	90,345	245,057	149,075	11,607	8,576	....	....
Utah	57,307	77,769	17,729	17,093	....	....	....	....
West Virginia	4,529	3,170	147,785	58,789	....	....	....	....
Other States a	1,672	1,423	66,673	40,012	6,852	3,637	....	....
Total	3,514,748	2,249,827	6,153,296	2,158,386	2,602,737	799,405	327,304	147,434

a Includes New Mexico, Pennsylvania, Porto Rico, and Virginia.

Production of salt in 1910, by States and grades, in barrels—Continued.

States.	Coarse solar.		Rock.		Other grades and brine.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
California	466,614	$146,193	78,571	$39,000	2,622	$2,929	937,514	$519,66
Hawaii	7,879	6,570					11,450	9,57
Idaho			350	386	136	190	885	1,12
Kansas			1,338,357	266,058	19,234	5,737	2,811,448	947,36
Louisiana			(a)	(a)			(a)	(a)
Michigan			247,582	79,226	4,104,934	211,317	9,452,022	2,231,26
Nevada	10,929	7,300					17,535	10,60
New Mexico							(b)	(b)
New York	439,778	129,295	c 5,256,307	c 1,214,639	3,084,450	158,882	c 11,642,520	c 2,585,73
Ohio	32,857	6,900			1,512,243	77,875	3,673,850	951,96
Oklahoma	1,314	518					2,564	88
Pennsylvania							(b)	(b)
Porto Rico							(b)	(b)
Texas	24,757	18,872			7,500	5,700	382,164	272,56
Utah	122,243	65,947	44,771	13,804	7,800	11,256	249,850	185,86
Virginia							(b)	(b)
West Virginia					3,311	996	155,625	62,95
Other States d	117,000	36,900			776,032	38,802	968,229	120,77
Total	1,223,371	418,495	6,965,938	1,613,113	9,518,262	513,684	30,305,656	7,900,34

a Included in New York.
b Included in Other States.
c Includes Louisiana.
d Includes New Mexico, Pennsylvania, Porto Rico, and Virginia.

THE SALT INDUSTRY BY STATES.

In 1910 salt was produced in the United States 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. The salt-producing localities in the United States are indicated on the accompanying map (Pl. XVII). Descriptions of the salt industry in some of the States and Territories follow:

CALIFORNIA.

The salt output of California in 1910 came from Alameda, Los Angeles, San Bernardino, San Diego, and San Mateo counties. Practically all the salt produced in this State is obtained from sea water by the solar evaporation process. In the manufacture of the finer grades the coarse solar salt is redissolved and then recrystallized in vacuum pans or in other ways. One company reports a production of salt obtained by mining.

In the quantity of salt produced in 1910 California ranks sixth among the States, as in the preceding year. In the value of output it has ranked fifth since 1907. The output of the State in 1910 was 937,514 barrels, or 131,252 short tons, valued at $519,667, that is, 55 cents per barrel or $3.95 per ton, as compared with 63 cents per barrel, or $4.50 per ton in 1909. These returns indicate on the whole a prosperous year for California salt, although one of the firms reported adverse conditions from floods. Such meteorologic conditions as floods are in large part responsible for the high price of California salt as compared with the price of salt in other parts of the United States.

HAWAII.

The manufacture of salt in the Territory of Hawaii is confined to the island of Oahu, and six firms have been reported to the Survey as producing salt in 1910. It is understood that the local supply is not equal to the demand, and that salt has to be imported from California. The quantity of salt produced in Hawaii in 1910 amounted to 11,450 barrels, or 1,603 tons, valued at $9,570, as compared with 7,796 barrels, or 1,091 tons, valued at $5,292, in 1909.

IDAHO.

The production of salt in Idaho in 1910 was 885 barrels, or 124 tons, valued at $1,127, as compared with 793 barrels, or 111 tons, valued at $1,118 in 1909. The salt came from the southeastern part of the State, in Bannock and Bear Lake counties, but the headquarters of most of the operators are across the State line, at Afton and Auburn, Wyo. A complete account of the salt resources along this part of the Idaho-Wyoming border, by C. L. Breger, was published recently in one of the annual economic bulletins of the Survey, and the article was abstracted in the chapter on salt and bromine for 1909. As the publications containing Breger's article are still in stock, the descriptions will not be repeated here. The work is cited in the bibliography at the end of this chapter, under both Idaho and Wyoming.

KANSAS.

Kansas ranked fourth among the States in 1910 in both quantity and value of salt produced. The output of the year amounted to 2,811,448 barrels, or 393,603 short tons, valued at $947,369, as compared with an output of 2,769,849 barrels, or 387,779 short tons, valued at $782,676, in 1909. The salt was produced at Ellsworth and Kanopolis, Ellsworth County; Lyons and Sterling, Rice County; Hutchinson, Reno County; and Anthony, Harper County. A new company, the Standard Salt Co., reported building a new salt plant in Rice County, with the expectation of starting operations early in 1911.

Salt is obtained in two ways in Kansas: (1) By the mining of rock salt, and (2) by the evaporation of brine. By far the larger part of the salt is obtained by evaporation. The subject of salt mining in Kansas has been fully described in two papers, one by Samuel Ainsworth and the other by C. M. Young, referred to in this report for 1909 and cited again in the bibliography at the end of this chapter.

In 1887 and 1888 the important salt beds of Kansas were found while drilling for oil and gas. They have been developed in an area located in the south-central part of the State comprised in Rice, Reno, Kingman, and parts of the adjoining counties, including Saline, McPherson, Harvey, Sedgwick, Sumner, Harper, Barber, Pratt, Stafford, Barton, and Russell. In the early history of the industry numerous shafts were sunk to the salt deposits, but from lack of experience and of funds to carry on the work many of the works proved failures. Only four important operations may be listed among the plants mining rock salt in recent years, and one of these plants, namely, that of the Kingman Salt Co., was destroyed by fire late in 1908, and has never been rebuilt. Only three other salt mines in Kansas have ever produced salt to any extent.

According to Mr. Ainsworth,[1] who discusses the Kansas rock-salt mining industry, the important salt beds of Kansas were discovered in 1887 and 1888 in the search for oil and gas, and they lie in the south central part of the State. He describes briefly the geology and location of the beds and the mines and mills of the Bevis Rock Salt Co., the Royal Rock Salt Co., and the Crystal Rock Salt Co.

Mr. Young [2] treats of the evaporated salt industry, which has its center at Hutchinson. He describes the manner of obtaining the brine from the wells, the various processes—direct heat process, grainer process, vacuum pan process—of converting the brine into salt, the methods of handling the salt, and the productive capacity of the district.

LOUISIANA.

Louisiana ranked fifth among the States in the quantity and sixth in the value of the salt produced in 1910. The salt mined in Louisiana came from Weeks and Avery Islands, so called, located in Iberia Parish. 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 Co., 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.[3] 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.

Salt is also mined on Avery Island, so called, located in Iberia Parish, 10 miles southwest of New Iberia. Rock salt was discovered here in 1862, and an 8-foot 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, in which the company is now working.

The details connected with the mining of salt in Louisiana have been published in this report for 1909 and will not be repeated here. They are also given in extenso in the publication by Gilbert D. Harris, cited under Louisiana in the bibliography at the end of this chapter.

MICHIGAN.

Michigan ranked second among the States in 1910 in both quantity and value of the salt produced. The output of the State during the year amounted to 9,452,022 barrels, or 1,323,283 tons, valued at $2,231,262. There is included in these figures the salt contained in the brine which is worked up into soda and other chemicals.

[1] Ainsworth, Samuel, Eng. and Min. Jour., Sept. 4, 1909, pp. 454–456.
[2] Young, C. M., Eng. and Min. Jour., Sept. 18, 1909, pp. 558–561.
[3] Harris, G. D., Rock salt in the State of Louisiana: Bull. Louisiana Geol. Survey No. 7, 1908, p. 5.

One of the most interesting recent events in the Michigan salt industry is the completion of the shaft of the Detroit Salt Co. This marks the close of another American feat of engineering carried on under great difficulty, which has taken between four and five years to complete. A description of the shaft, together with other data connected with it has been published by Albert H. Fay.[1]

Recent changes in Michigan salt industry.—The Kern Manufacturing Co. reported that it went out of business in 1910 and that its salt block is now torn down. The Dennis Bros. Salt & Lumber Co. has entirely discontinued the manufacture of salt. Butters Salt & Lumber Co. has dissolved and reported no production in 1910. The Sicken Salt & Stave Co.'s plant was destroyed by fire early in November, 1910. The Rouge River Salt Co. was also reported out of business in 1910.

NEVADA.

The output of salt in Nevada in 1910 amounted to 17,535 barrels, or 2,455 tons, valued at $10,600. Though the quantity of salt produced is much larger than that reported for the preceding year, there is considerable falling off in the value of the product, which amounted to $19,847 in 1909. As heretofore, Nevada's salt was reported from Churchill, Esmeralda, and Washoe counties.

NEW MEXICO.

As usual, Torrance County furnished the only commercial salt reported to the Geological Survey from this Territory in 1910. The salt was produced by solar evaporation.

NEW YORK.

New York ranked first among the States in the production and value of salt in 1910. As the returns from Louisiana have been united with those of New York for concealment, the production of New York will not be given. In addition to the salt produced as such in this State, the returns from New York include the salt content of the brine that is worked up into sodium compounds—by the Solvay Process Co. near Syracuse, for example.

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 by 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 100 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

[1] Eng. and Min. Jour., Mar. 18, 1911, p. 565 et seq.

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 1910 came from near Syracuse, Onondaga County; Le Roy, Genesee County; Cuylerville, Piffard, and Retsof, Livingstone County; Watkins, Schuyler County; Ithaca and Myers, Tompkins County; and Rock Glen and Silver Springs, Wyoming County.

OHIO.

Ohio ranked third among the States in both quantity and value of the salt produced in 1910, being surpassed by New York and Michigan. The production of the State amounted to 3,673,850 barrels, or 514,339 tons, valued at $951,963, as compared with an output of 3,684,775 barrels, or 515,868 tons, valued at $993,700 in 1909, a decrease for the year 1910 of 10,925 barrels, or 1,529 tons, in quantity and of $41,737 in value. A complete description of the salt deposits of Ohio and 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 a few years ago 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.

OKLAHOMA.

The small production of salt reported from Oklahoma in 1910 came from the west-central part of the State, in Blaine County, and from the extreme southwestern part of the State in Harmon County.

PENNSYLVANIA.

As heretofore, the salt output of this State was reported from Allegheny County.

PORTO RICO.

The quantity of salt produced in Porto Rico in 1910 was less than that in 1909, but the value of the output was considerably greater. In order to conceal the individual output from the island, it is necessary to suppress the figures for 1910.

TEXAS.

The quantity of salt produced in Texas in 1910 amounted to 382,164 barrels, equivalent to 53,503 tons, valued at $272,568. In 1909 the corresponding figures were 409,315 barrels, or 57,304 short tons, valued at $260,286. Though the quantity of salt produced in 1910 was 27,151 barrels, or 3,801 tons less than in the preceding year, the value of the output in 1910 was $12,282 greater than in the preceding year.

Salt in Texas occurs along the Gulf coast and in many "salines" or lagoons 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 1910 amounted to 249,850 barrels, or 34,979 tons, valued at $185,869. This production was slightly in excess of that for 1909, which was 246,935 barrels, or 34,571 tons, valued at $147,318. The salt is reported from Salt Lake and Sevier counties. In Salt Lake County the salt is obtained from the water of Great Salt Lake, and an account of the methods of production employed was published in this report for 1909.

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, in the southwest corner of the State. As this company is the only producing company in the State, the statistics of production are concealed.

WEST VIRGINIA.

The production of salt in West Virginia in 1910 amounted to 155,625 barrels, or 21,787 tons, valued at $62,955, as compared with 150,492 barrels, or 21,069 tons, valued at $76,463 in 1909.

The salt industry in West Virginia has been described recently by G. P. Grimsley,[1] and an account of the industry, based on Grimsley's report was published in this report for 1909. The salt industry in West Virginia is confined to two localities, (1) Malden, Kanawha County, 6 miles above Charleston, on the Kanawha & Michigan Railroad, on the north bank of Kanawha River, and (2) Hartford, Mason County, on Ohio River opposite Pomeroy, Meigs County, Ohio. In 1910 salt was reported from both of these districts.

DOMESTIC CONSUMPTION.

In the following table is given the proportion of salt produced in the United States which enters into domestic consumption. Of the total quantity of salt consumed in 1910 in the United States, 96.8 per cent was of domestic production, and only 3.2 per cent was imported. The United States has long been in a position to supply more than its own needs, and a great deal of salt that still remains unexploited in this country is prevented from entering the market,

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[1] West Virginia Geol. Survey, vol 4, pt. 2, 1909, pp. 286-354

owing to the keen competition that exists in the salt industry. The consumption of salt is shown in the following table:

Supply of salt for domestic consumption, 1880–1910, in barrels.

Source.	1880.	1890.	1900.	1909.	1910.
Domestic production	5,961,060	8,876,991	20,869,342	30,107,646	30,305,656
Imports	3,427,639	1,838,024	1,427,921	1,067,999	979,305
Total	9,388,699	10,715,015	22,297,263	31,175,645	31,284,961
Exports	4,436	17,597	53,650	286,810	350,094
Domestic consumption	9,384,263	10,697,418	22,243,613	30,888,835	30,934,867
Comparison with preceding year		+877,610	+1,274,634	+1,116,659	+46,032
Percentage of imports to total consumption.	36.5	17.2	6.4	3.4	3.2

IMPORTS.

There were imported into the United States, in 1910, 274,205,582 pounds, or 979,306 barrels, of salt, valued at $370,922. The corresponding importation in 1909 was 299,039,757 pounds, or 1,067,999 barrels, valued at $437,827. It is gratifying to record this decrease for the year 1910 in addition to that of the preceding year. The decline is marked in those grades of salt imported in packages and in certain grades of the salt imported in bulk. There was an increase in the amount of salt imported for curing fish. Salt of this grade comes to the seaport towns, chiefly those along the Atlantic coast. In the New England States, for example, salt from the West Indies and the Mediterranean countries competes strongly with New York salt. The New York product has to pay certain freight charges to the seaport towns, and these, together with the original cost of production, apparently are too great to enable it to compete with foreign salt. These imports are liable to increase rather than to decrease in the future, as the Payne-Aldrich tariff bill reduced the duty about 20 cents a short ton on all grades of salt imported into the United States.

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 six years is as follows:

Salt imported and entered for consumption in the United States, 1905–1910, 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
1910	53,143,200	178,000	118,796,400	104,822	102,265,982	88,100	274,205,582	370,922

EXPORTS.

The export of salt of domestic production from the United States from 1905 to 1910 is shown as follows:

Salt of domestic production exported from the United States, 1905–1910.

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
1910.......do....	98,026,369	320,926

In 1900 the salt exported from the United States amounted to 15,021,861 pounds, valued at $65,410. The exportations in 1905 had grown to the figure indicated in the table given above, namely, 68,475,356 pounds, valued at $239,223. The exported salt in 1910 amounted to 98,026,369 pounds, or 350,094 barrels, valued at $320,926. The quantity of salt exported in 1910 is an increase of 43 per cent as compared with the exportation in 1905, and of 22 per cent as compared with that in 1909. The increase in the salt exported from this country made a notable advance in 1910 and was the largest yet reported by the Geological Survey.

BROMINE.

PRODUCTION.

The following table gives the production and value of the bromine produced in the United States since 1880:

Production and value of bromine, 1880–1910.

1880......pounds..	404,690	....
1883........do....	301,000	....
1884........do....	281,100	$67,464
1885........do....	310,000	89,900
1886........do....	428,334	141,350
1887........do....	199,087	61,717
1888........do....	307,386	95,290
1889........do....	418,891	125,667
1890........do....	387,847	104,719
1891........do....	343,000	54,880
1892........do....	379,480	64,502
1893........do....	348,399	104,520
1894........do....	379,444	102,450
1895........do....	517,421	134,343
1896........do....	546,580	144,501
1897......pounds..	487,149	$129,094
1898........do....	486,979	126,614
1899........do....	433,004	108,251
1900........do....	521,444	140,790
1901........do....	552,043	154,572
1902........do....	513,893	128,472
1903........do....	598,500	167,580
1904........do....	897,100	269,130
1905........do....	1,192,758	178,914
1906........do....	1,283,250	165,204
1907........do....	1,379,496	195,281
1908........do....	760,023	73,783
1909........do....	569,725	57,600
1910........do....	245,437	41,684

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,[1] and an account of the industry, based on Grimsley's report, appeared in this chapter for 1909. Accounts of the industry in Michigan and Ohio have appeared in previous volumes in the chapter on salt and bromine, to which the reader is referred for detailed information.

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[1] West Virginia Geol. Survey, vol. 4, 1909, pp. 286–354.

CALCIUM CHLORIDE.

In connection with the salt and bromine industry in Ohio, Michigan, Pennsylvania, and West Virginia, there is produced a considerable quantity of calcium chloride. The production of this commodity in 1910 in the States above mentioned amounted to 10,971 short tons, valued at $74,713.

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SULPHUR AND PYRITE.

By W. C. Phalen.

SULPHUR.

INTRODUCTION.

The sulphur industry in the United States in 1910 was confined to the four States Louisiana, Nevada, Utah, and Wyoming, the production of the other States being practically negligible as compared with that of Louisiana. The sulphur industry of these States has been described in previous volumes of "Mineral resources of the United States," the descriptions comprising the geologic occurrence of the sulphur, its mode of origin, technology, etc. The chapter for 1909 has but recently appeared and is still available for distribution. In the chapter for 1910 is incorporated a detailed account of the important foreign sulphur deposits as a matter of record at the present time and for future reference.

PRODUCTION.

The production of sulphur for 1910 was 255,534 long tons, valued at $4,605,112, as compared with 239,312 long tons, valued at $4,432,066, in 1909, an increase in 1910 of 16,222 tons in quantity and of $173,046 in value.

The production of sulphur in this country since 1880 is shown in the following table:

Production of sulphur in the United States, 1880–1910.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
	Long tons.			*Long tons.*	
1880	536	$21,000	1896	4,696	$87,200
1881	536	21,000	1897	2,031	45,590
1882	536	21,000	1898	1,071	32,960
1883	893	27,000	1899	4,313	107,500
1884	446	12,000	1900	3,147	88,100
1885	638	17,875	1901	[a]241,691	1,257,879
1886	2,232	75,000	1902	[a]207,874	947,089
1887	2,679	100,000	1903	[a]233,127	1,109,818
1888	....	....	1904	127,292	2,663,760
1889	402	7,850	1905	181,677	3,706,560
1890	....	....	1906	294,153	5,096,678
1891	1,071	39,600	1907	293,106	5,142,850
1892	2,400	80,640	1908	369,444	6,668,215
1893	1,071	42,000	1909	239,312	4,432,066
1894	446	20,000	1910	255,534	4,605,112
1895	1,607	42,000			

a Includes the production of pyrite.

IMPORTS.

In 1910 there were imported into the United States 30,833 lon tons of sulphur, including crude sulphur, refined sulphur, flowers o sulphur, and all other kinds. The total value of this imported su phur amounted to $558,611. The corresponding figures for 190 were 30,589 long tons, valued at $549,632. Thus the importation o 1910 exceeded that of 1909 by 244 long tons in quantity and $8,97 in value.

In the following table the importation of sulphur by kinds is give for the last five years:

Sulphur imported and entered for consumption in the United States for the calendar yea 1906–1910, by kinds, in long tons.

Year.	Crude.		Flowers of sulphur.		Refined.		All other.[a]		Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
1906	72,404	$1,282,873	1,100	$29,565	709	$17,918	28	$3,224	$1,333,58
1907	20,399	355,944	1,458	41,216	606	14,589	60	8,426	420,17
1908	19,620	318,577	793	22,562	693	17,227	30	4,013	362,37
1909	28,800	492,962	770	23,084	966	26,021	53	7,565	549,63
1910	28,656	496,073	1,024	30,180	1,106	25,869	47	6,489	558,61

[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 and by ports at which it was received, for the years 1908 to 1910:

Statement, by countries and by customs districts, showing the imports into the United States of crude sulphur or brimstone each calendar year, 1908–1910, in long tons.

Countries whence exported and customs districts through which imported.	1908		1909		1910	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
COUNTRY.						
Canada	26	$485	297	$7,235	5	$160
United Kingdom		13	2	58	7	199
Italy	12,950	197,203	10,369	194,834	10,704	201,993
Japan	7,055	119,457	15,800	250,639	17,377	283,232
Other countries	87	1,419	446	6,188	554	10,404
Total	20,118	318,577	26,914	458,954	28,647	495,988
CUSTOMS DISTRICT.						
Baltimore, Md			5,586	105,436	4,312	80,756
Boston and Charlestown, Mass	1	18			5	121
New York, N. Y	7,366	114,939	4,601	85,059	6,817	128,794
Los Angeles, Cal			608	9,711	754	12,424
San Francisco, Cal	10,231	157,847	10,132	158,588	7,310	116,595
Willamette, Oreg	1,978	35,691	4,342	68,780	7,623	124,643
Hawaii					1,200	21,160
All other	542	10,082	1,645	31,380	626	11,495
Total	20,118	318,577	26,914	458,954	28,647	495,988

EXPORTS.

In 1910 the United States exported 30,742 long tons of sulphur, valued at $552,941; in 1909 this exportation amounted to 37,142 long tons, valued at $736,928.

PHYSICAL AND CHEMICAL PROPERTIES OF SULPHUR.

Sulphur crystallizes in the orthorhombic system, chiefly in the acute pyramidal form; more rarely it is sphenoidal in habit. It often occurs in spherical or kidney-shaped masses, as incrustations, in stalactitic or stalagmitic form, and powdered as flowers of sulphur. The fracture of crystalline sulphur is conchoidal; its luster, resinous. The fracture of the earthy form is splintery with a slight luster. The color of sulphur is honey yellow, "sulphur yellow," or yellowish brown, but as a result of impurities it may be also reddish, greenish, or gray. At low temperatures the colored varieties gradually fade and at $-50°$ C. become colorless.

Sulphur is a nonconductor of electricity, but through friction it becomes negatively electrified. In thin plates it is opaque to the passage of Roentgen rays. Its hardness varies from 1.5 to 2.5; its specific gravity from 2 to 2.1. Its melting point is 108° C. (but according to some authorities 114° C.); its boiling point is 450° C. It takes fire at 270° C. and burns to sulphur dioxide (SO_2). The best solvent of sulphur is chloroform ($CHCl_3$) or carbon disulphide (CS_2). Small quantities of selenium, bitumen, and also, rarely, of sulphide of arsenic are sometimes associated with it.

THE SULPHUR INDUSTRY.[1]

ITALY.

THE FOUR DISTRICTS.

Italy is the leading country of the world in the production of sulphur. Italian sulphur comes from four districts, Sicily, Romagna and Marches, Campania and Calabria, and Siena, the relative importance of which is evident from the following table, which gives the districts and the mining headquarters or the main office of each district, the number of productive mines in each, the production in metric tons,[2] the average content of sulphur in the crude ore of the different districts, and the value of the production in dollars for the years 1909 (and 1908).[3]

Production of sulphur in Italy in 1909 and 1908, in metric tons.

Main office.		Number of productive mines.	Production of crude ore in metric tons.	Average percentage of sulphur in crude ore.	Value of production.
Caltanissetta (for Sicily)	1909	380	2,616,013	25.00	$5,671,890
	1908	404	2,633,924	25.00	5,581,964
Bologna (for Romagna and Marches)	1909	10	132,500	30.00	376,427
	1908	11	142,700	16.80	411,189
Naples (for Campania and Calabria)	1909	10	75,851	22.00	221,347
	1908	10	69,019	20.00	198,522
Florence (for Tuscany, Siena)	1909	1	3,091	16.00	5,966
	1908	1	2,300	24.00	2,663
Total	1909	401	2,827,455	25.18	6,275,630
	1908	426	2,847,943	....	6,194,338

[1] Translated from Stutzer, O., Die wichtigsten Lagerstätten der "Nicht-Erze" [The more important deposits of the nonmetallic minerals], Borntraeger Bros., Berlin, 1911, 474 pp., 108 figs.
[2] A metric ton is equivalent to 2,204.6 pounds.
[3] The figures for the year 1908 in this and subsequent tables were taken from Rivista del Servizio Minerario by Stutzer.

SICILY.

GEOGRAPHIC DISTRIBUTION OF THE SICILIAN SULPHUR DEPOSITS.

The minable sulphur deposits of Sicily are located between Gibellina (Province o Trapani) on the west and Centuripe (Province of Catania) on the east. They extenc

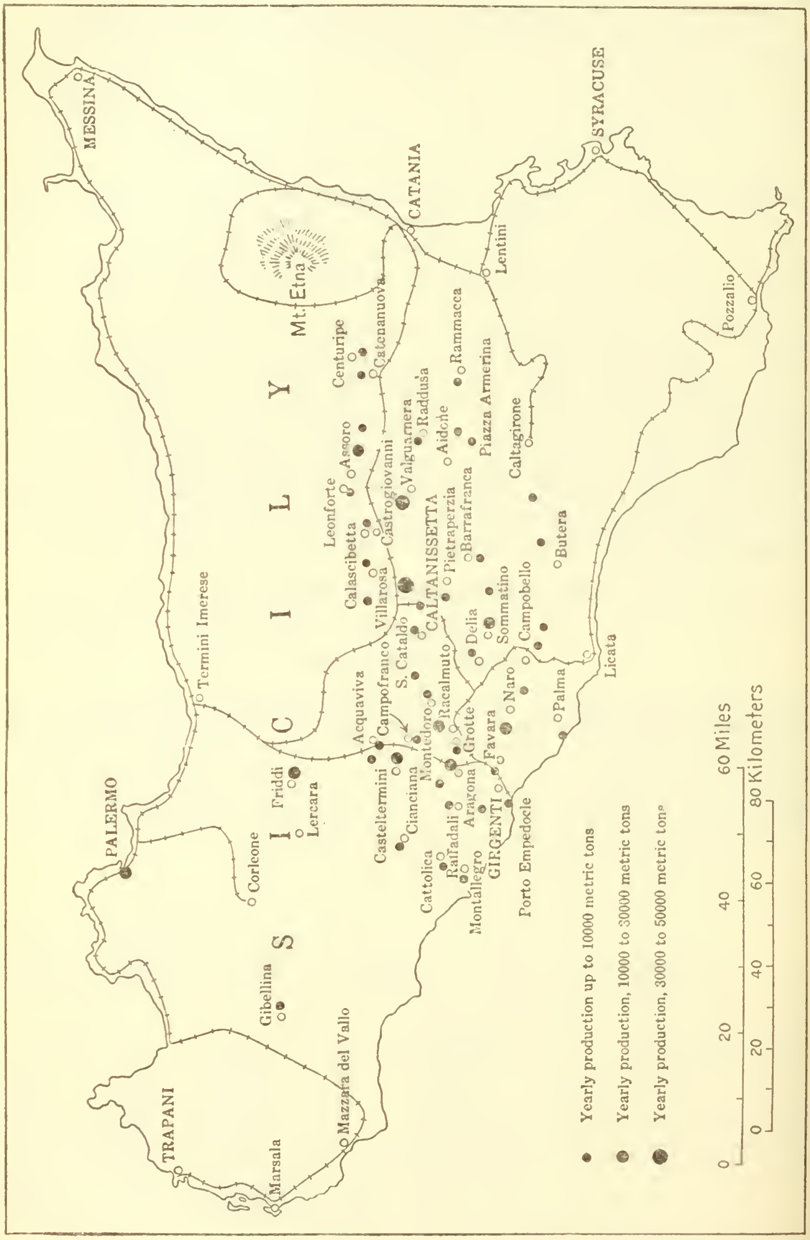

FIGURE 8.—Map of Sicily showing location and production of sulphur deposits.

as far as the coast in a southerly direction. The greatest length of the sulphur-bearing district as a whole is 99 to 105 miles; its greatest width 53 to 56 miles. Within this extensive area occur the richer deposits, concentrated at different points, as indicated on figure 1.

It is quite possible that sulphur deposits were in earlier geologic time scattered over the entire island, but were later removed by mountain-making processes and by the denudation and erosion which followed them. Thus no sulphur deposits are found in the northeastern and the extreme southeastern parts of the island. In other places the sulphur-bearing beds are covered by later deposits and their study is thus prevented.

MINERALOGY AND GEOLOGY OF THE SICILIAN SULPHUR DEPOSITS.

The sulphur in Sicily is found chiefly in an argillaceous limestone ("mergeligen Kalkstein"), associated with gypsum and bituminous marl ("Tufi"). Its structure is massive, or coarsely crystalline, but usually compact. Its color is brown or brownish gray, occasionally light yellow. The darker color is usually due to the intimate admixture of bituminous substances.

The sulphur-bearing rocks occur in the form of immense lenses rather than as extensive beds, as this term is commonly understood, the lenses being of variable thickness and richness. Three to four sulphur layers usually are present. The Solfara Grande di Sommatino mine has six successive layers, varying individually from 3 feet to more than 8 feet and even up to nearly 100 feet. The thickness of the barren rock between the sulphur layers is, as a rule, less than 3 feet.

Within the sulphur-bearing layer proper the sulphur occurs either in the form of irregular incrustations and small pockets, intimately mixed with the limestone, or as thin bands (1 to 2 millimeters thick) interlaminated with the country rock.

This banded or bedded structure—the "struttura soriata," so called—may be of two kinds—type A, in which massive argillaceous limestone in thick beds may alternate with thin compact sulphur layers, and type B, in which at the lower boundary of the limestone with the sulphur (that is, at the top of the sulphur layer) there may be present a layer or band of crystalline calcite, whose terminations project downward into the empty space above the sulphur. The thickness of these individual layers may reach a few centimeters. This bedded type was first studied by S. Mottura at the Solfara Grande di Sommatino mine and later (1910) by O. Stutzer at the Gessolungo-Trigona mine. Transitional phases between the compact and the drusy varieties of the bedded structures are often observed. It is held therefore that one type has originated from the other—that the type B associated with the drusy calcite is secondary and that the compact type A is primary, although the crystalline habit of its sulphur may have well originated from the recrystallization of a more finely granular bed. The sedimentary origin of these bedded deposits has been more firmly established through further observations at the Gessolungo mine. The banded sulphur beds, for example, exhibit in many places in this mine typical cross-bedding, such as can arise only as a result of deposition in shallow water (delta formation). Furthermore, the lower of the two beds at this mine was eroded in some places before the formation of the upper. It is evident therefore that before the deposition of the upper bed the lower one had already formed.

A fairly safe index of the presence of sulphur deposits is the presence of the so-called briscale. This is formed by oxidation of the sulphur and by the action of the sulphuric acid thus formed on the limestone, which is ultimately converted to gypsum. The briscale is crystalline, porous, and yellow. A similar change takes place after a time under the influence of atmospheric agents in the material thrown on the dumps.

This briscale often serves in Sicily as a guide in the search for sulphur deposits. The experienced miner, moreover, is able to draw from it certain conclusions with respect to the original ore body itself. For example, if the briscale is firm or hard, as a result of the intimate mixture of crystalline gypsum, marl, or limestone, the primary deposit is poor in sulphur; but if the briscale has no crystalline structure, but is instead earthy, porous, and friable, the primary deposit is generally rich. In the immediate proximity of the underlying sulphur deposits, the combination of minerals given above is also an index of the amount of sulphur present—for example, if the briscale is thick it is safe to conclude that the underlying sulphur beds are likewise thick.

The minerals associated with the crystalline sulphur are chiefly celestite, aragonite, calcite, and gypsum, the latter in abundance in beautiful transparent crystals. All these minerals, together with the crystalline sulphur, are secondary products formed along joint planes, and in fissures and cavities. Among the secondary minerals, calcite has originated at the same time as the sulphur, as both minerals are mutually intergrown. In the cavities, calcite is present in the form of beautiful long white stalactites. Celestite crystals have often served as the starting point of these stalactitic masses. Calcite crystals also may pass into celestite. Crystalline sulphur of a later growth, as well as celestite, is associated with these stalactites, and this sulphur is incrusted with younger calcite (pseudomorphs by incrustation). Opal is rarely present among the accompanying minerals and has been found in the form of small brown stalactites or thin incrustations. Its dark color is due to the presence of bituminous substances. Barite is very rarely present in the form of tabular crystals. Celestite, where found in larger quantities, was formerly mined and exported as at Favara, Licata, Caltanissetta, and Sommatino. At the Grotta Calda mine, it is present in alternating layers with limestone and sulphur, and in the lower beds is from 2.75 inches to more than 3 inches thick (7–8 centimeters). The bituminous clay which accompanies the sulphur often contains large quantities of asphalt, as at Giona, near Racalmuto, where it was formerly worked. From the last-named place, a rare mineral, melanophlogite, may be obtained. It occurs in small cubes or as thin incrustations on the sulphur and has the following composition:

Composition of melanophlogite.

Silica (SiO_2)	89.46
Sulphuric acid (SO_3)	5.60
Carbon (C)	1.33
Ferric oxide (Fe_2O_3)	.25
Volatile	2.42
	99.06

A definite paragenetic series of minerals associated with the sulphur deposits can not be given. Only aragonite appears to be exclusively older. In specimens in the Freiberg collection of ore deposits aragonite also appears as a later growth upon the sulphur. Quartz, opal, and melanophlogite, besides the omnipresent sulphur, belong in the group of latest minerals.

Gaseous emanations of hydrocarbons, carbonic acid, and hydrogen sulphide are often encountered in the mines. When tapped, these gases are emitted with great force and are a source of great danger to the miners.

The sulphur content of the deposits in the western part of the island is not so great as toward the central part. The richer deposits carry 15 to 20 per cent sulphur, but individual deposits are known with 50 per cent, and in places, as, for example, at Naro, 80 to 90 per cent ore is found. A few deposits contain 12 to 15 per cent. The average content of the ore according to Mottura is 20 to 21 per cent. Ore carrying less than 8 per cent is not considered workable. The workable deposits carrying up to 40 per cent sulphur are considered as limestone impregnated with sulphur; above 40 per cent, as more or less impure sulphur.

TECHNICAL AND STATISTICAL DATA.

The methods of mining Sicilian sulphur are very simple. The ore is mined by shafts, leading into which are steps hewn out of the rock. A few mines have modern hoisting machinery and trams. The stall and pillar method is practiced in a primitive way. The shafts are not very deep, from 500 to 825 feet. The crude ore is heated, and the sulphur, which melts at 115° C., runs off and is collected. Two methods of heating the sulphur are employed: (1) By burning part of the sulphur in the so-called calcaroni and beehive ovens, and (2) by means of superheated steam.

In 1906 there was obtained by these different methods the following output of sulphur:

Output of sulphur in Sicily in 1908.

	Quantity.	Percentage of the total quantity.
	Metric tons.	
Ovens	217,279	59.79
Calcaroni	118,938	28.76
Superheated steam	41,098	9.94
Roasting	2,619	.63
Other methods	3,646	.88
Total	[a] 413,580	100.00

[a] The figures add to 383,580 and not to 413,580, as given in the original. The percentages also do not figure out as given in the original.

The figures for the year 1909 correspond with those given above.

The sulphur obtained is not all of the same value. Various grades are distinguished in the trade. The different grades are named as follows in the ports of Licata, Girgenti, and Catania:

Grades of Sicilian sulphur at ports.

First quality: Practically pure sulphur.
Second quality: (*a*) Best (vantaggiata), only slightly different from the first quality.
(*b*) Good (buona), with 4 to 5 per cent of impurities, but with a beautiful yellow color.
(*c*) Current (corrente), with more impurities than *b;* dirty yellow in color.
Third quality: (*a*) Best (vantaggiata), yellowish brown from bituminous matter.
(*b*) Good (buona), brown, transparent, containing more bituminous matter than *a*.
(*c*) Current (corrente), brown, not homogeneous.

At Palermo, where only sulphur from Lercara is shipped, two grades are distinguished—Lercara No. 1 and No. 2. There has been an attempt in recent years to supplant the older methods of distinguishing the different grades by four new names, as follows: (1) Superior yellow (gialla superiore); (2) inferior yellow (gialla inferiore); (3) superior brown (bruna superiore); and (4) inferior brown (bruna inferiore).

The following table shows the quantity and value of the sulphur produced in 1908. The prices are those on board ship at the three ports, Catania, Porto Empedocle, and Licata, whence practically all the Sicilian sulphur is exported.

Output and value of Sicilian sulphur on board ship in 1908.

Quantity of sulphur delivered at all three ports.	Average value in dollars per ton.				Total value of sulphur.
	Catania.	Porto Empedocle.	Licata.	The three harbors combined.	
Metric tons.					
64	....	....	$18.13	$18.13	$1,160
58,291	$19.09	$18.55	18.55	18.58	1,082,861
35,954	18.78	17.92	18.26	18.44	662,810
54,638	18.53	17.93	18.26	18.35	1,002,502
110,181	18.34	17.88	17.94	18.16	2,001,232
82,345	18.06	17.62	17.72	17.75	1,461,802
65,385	17.71	17.27	17.40	17.36	1,135,373
406,858	18.37	17.80	18.01	18.04	7,347,740

The average value for the three harbors combined was obtained by dividing the total value by the quantity of sulphur delivered at all three ports.

For many years Sicily held a monopoly of the world's sulphur market. This monopoly has recently been broken by the exploitation of the sulphur deposits of Louisiana. As a result of this, in the year 1908 alone 80 small mines in Sicily were forced to suspend operations, leaving 404 still in operation. In 1909 the number of mines was still further reduced to 380.

Information with reference to the number and condition of Sicilian mines is given in the following table:

Number and condition of sulphur mines in Sicily, 1905–1909.

Year.	Mines producing more than 1,000 metric tons.	Mines producing less than 1,000 tons.	Unproductive mines.	Total.
1905	98	618	61	777
1906	92	492	32	616
1907	74	426	41	541
1908	81	323	40	444
1909	76	304	45	425

The following table gives the exportation from 1902 to 1909 of Sicilian sulphur to foreign countries. It will be seen that the exports to North America decreased from 176,845 tons in 1902 to 16,972 tons in 1909.

Exports of sulphur from Sicily, 1902–1909, by countries, in metric tons.

[From Rivista del Servizio minerario.]

Country.	1902	1903	1904	1905	1906	1907	1908	1909
Continental Italy	42,582	46,974	80,331	102,830	81,323	54,743	60,134	49,692
Austria	20,224	19,181	23,768	25,052	24,703	26,390	22,086	26,560
Belgium	12,503	14,738	13,892	14,892	8,538	8,066	8,746	16,377
Denmark	407	225	234	1,214	787	1,594	114	335
France	68,760	79,727	115,897	97,340	71,021	59,868	96,448	90,239
Germany	26,257	33,350	32,824	31,825	40,113	35,059	30,229	28,538
Greece	13,701	14,690	17,886	17,504	18,980	22,158	16,252	12,004
Great Britain and Malta	26,581	24,452	20,957	23,751	18,687	17,929	20,597	19,860
Holland	8,677	5,500	9,000	5,192	10,037	14,951	9,812	8,708
Portugal	10,630	12,915	8,554	12,969	12,192	10,371	12,609	14,379
Russia	17,817	20,445	15,039	17,013	18,174	21,244	14,068	18,584
Spain	2,171	6,242	4,202	3,532	3,776	2,957	4,977	6,657
Scandinavia	23,434	25,683	18,867	14,344	20,818	21,821	30,252	19,570
European Turkey	1,258	2,773	2,480	2,000	1,672	5,745	2,213	1,290
United States and Canada	176,845	157,259	107,994	68,897	37,725	4,073	12,484	16,972
Central and South America	793	1,093	3,159	1,789	2,652	3,386	3,403	6,814
Egypt	2,666	772	244	335	287	485	205	348
Algeria and Tunis	4,765	5,658	5,093	4,701	4,978	4,375	4,527	5,792
Asiatic Turkey	4,892	4,384	5,745	3,576	4,484	68	6,373	3,015
British India	2,507	3,964	3,827	2,960	4,570	4,607	3,319	4,613
Australia	5,192	5,700	7,223	3,877	1,905	1,151	5,748	2,312
Other countries	6,944	6,176	9,453	12,151	14,199	17,912	10,477	11,854
Total	479,706	491,901	506,669	467,744	401,627	341,951	375,073	364,513

One result of the falling off in the exportation of Sicilian sulphur is overproduction, and, as a consequence, the accumulation of stocks at the different ports. These stocks at the end of the respective years are shown for the period 1901–1909 in the following table:

Stocks of sulphur at various ports of Sicily, 1901–1909.

1901	metric tons	310,123
1903	do	361,220
1905	do	462,437
1906	do	525,115
1908	do	618,459
1909	do	647,567

The stocks on hand at the end of 1909 at the different ports were as follows:

Stocks of sulphur at Sicilian ports Dec. 31, 1909, by ports.

	Metric tons.
Porto Empedocle	430,962
Licata	157,592
Catania	55,893
Termini Imerese	3,081
Palermo	352

ROMAGNA AND MARCHES.

The sulphur deposits of Romagna [1] and Marches are very similar to the Sicilian deposits as regards their occurrence, origin, and mineral contents.

Geographically the deposits are located within two straight lines, the northern of which joins the two cities Forli and Pesara, located on the railroad running between

[1] Geologic literature on the sulphur deposits of Romagna and Marches is very meager. A short catalogue was published by the Corpo reale delle miniere and distributed at the St. Louis fair. In addition, the following references may be useful: Bombicci, L., Descrizione degli esemplari di solfo nativo cristallizzato delle solfare di Romagna, raccolti e classificati dall' autore nel museo mineralogico della R. Università di Bologna: Mem. Accad. Bologna, 27 Mai 1894, vol. 4, p. 737; Perrazi, C., Le soufre en Italie: Annales des mines, 6th ser., vol. 7, 1865, cited in Kurze Notizen: Berg- und Hüttenm. Ztg., vol. 21, 1866, p. 92.

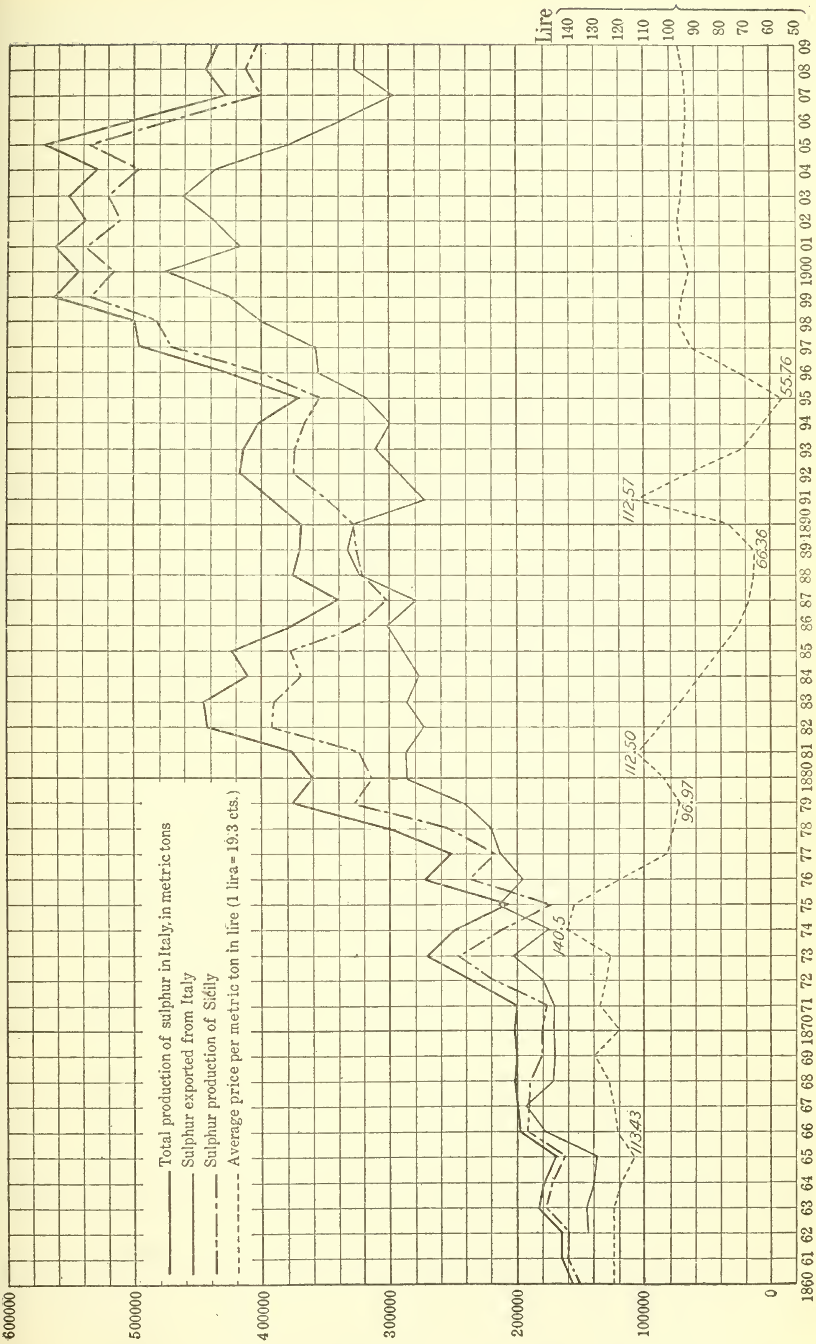

FIGURE 9.—Production, exports, and price of sulphur in Italy.

Bologna and Ancona, and the southern of which joins Sarsina and Urbino. In the midst of the area thus inclosed is the small Republic of San Marino.

In the district as a whole, four larger groups of mines may be distinguished, located as follows: (1) In the basin of Cesenate; (2) in the basin of Montefeltro; (3) in the basin of Urbinate; and (4) in the basin of Cabernadi.

The following table gives the production of crude sulphur in Romagna from 1907 to 1909:

Production of crude sulphur in Romagna, 1907–1909.

	Quantity.	Price per ton at refinery.
	Metric tons.	
1907	21,926	$18.34
1908	25,105	18.34
1909	23,068	18.34

CAMPANIA.

The sulphur deposits of Campania [1] are located in the province of Avellino in the valley of Sabato about 7.5 miles from Avellino and Benevento. They are the only known occurrences in the large area between Calabria and Romagna.

The sulphur deposits of Campania were discovered in 1866. In 1909 (1908) three mines were in operation which produced 40,298 (33,815) metric tons of crude sulphur, valued at $169,346 ($147,957), or $4.20 ($4.37) per ton. There were employed at the mines 441 (403) miners.

CALABRIA.[2]

In the Province of Catanzaro, Calabria, sulphur mines are located in the neighbor hood of Cotrone, at Strongoli, San Nicola dell' Alto, Melissa, Casabona, and Verzino The entire sulphur-bearing area is only about 3 square miles in areal extent. Other workable sulphur deposits are unknown in Calabria, although beds of upper Miocene age are known in many other places in the Province.

In the year 1909 seven mines were active in Calabria, the total production of which was 35,553 metric tons, valued at $52,002, or $1.46 per ton. In 1908 the production was 35,204 metric tons, valued at $50,556, or $1.44 per ton.

SIENA.[3]

Northeast of Poggio Orlando in the Province of Siena a sulphur deposit is being mined. It is located close to the old lignite mine, near Casino, about 6.2 miles north of Siena. It occurs in upper Miocene beds, which extend from Boggione to Carfini. The lignite beds are younger than those containing the sulphur.

The deposit may be briefly described as follows: A dark-colored compact clay is underlain by crystalline gypsum, at the top of which occurs the sulphur-bearing layer 3 feet 11 inches (1.2 millimeters) thick and consisting of sulphur and calcite. The sulphur is massive generally, but rarely may be crystalline. In the footwall occurs concretionary, nonfossiliferous limestone, below which is found clay containing fresh-water fossils. Traces of sulphur are present in the hanging wall as well as in the footwall. The entire absence of marine sediments in the series is worthy of note. A similar but less important occurrence of sulphur is located at Arbiola, in the vicinity of Vagliagli.

The origin of the sulphur in the Province of Siena is analogous to that of the Sicilian sulphur—that is, it was formed by the reduction of calcium sulphate through the agency of organic substances. Pantanelli believes that the reduction was caused by bacteria.

In the year 1909 the mines produced 3,091 metric tons of sulphur ore, valued at $5,966. The number of men engaged in the mining operations was 37. In 1908 the production was 2,300 metric tons, valued at $2,663, and the number of men employed was 51.

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[1] Fuchs et de Launay, Gîtes minéraux, vol. 1, p. 282; Wolf, H., The sulphur deposits between Alta-Villa and Tufo, east-northeast of Naples: Verhandl. K. k. geol. Reichs-Anstalt, 1869, pp. 195–197; Deecke W., The sulphur-mining industry of Alta-Villa Irpina in lower Italy: Neues Jahrb., 1891, vol. 2, pp. 39–48; Catalogue of the Corpo reale delle miniere on the exhibition of Italian sulphur at the World's Fair in St. Louis, Rome, 1904.

[2] Catalogue of the Corpo reale delle miniere (of the St. Louis Exposition), Rome 1904.

[3] Pantanelli, D., Di alcuni giacimenti solfiferi della Provincia di Siena: Boll. Soc. geol. italiana, vol. 22, 1903; Zeitschr. prakt. Geologie, 1904, p. 278.

JAPAN.

The production of sulphur in Japan has increased in recent years.[1] In 1908 it amounted to 33,785 long tons, valued at $393,533. Japan occupies third place among the sulphur-producing countries of the world.

The sulphur deposits of the country are associated with volcanoes. Four types of deposits are distinguished, as follows:

1. Incrustations and impregnations of sulphur associated with the country rock of the solfataras, the sulphur having formed from the decomposition of sulphur-bearing gases.
2. Deposits formed from "flowing streams of sulphur—that is, from flowing mud mixed with sulphur blocks ejected during the eruption of a volcano."[2]
3. Sulphur deposits in old crater lakes.
4. Sulphur deposited from hot springs, analogous to sinter deposits.

Almost the entire production is derived from the first three types. The last-named type is exploited in a small way for medicinal purposes. Only the richest parts of the sulphur deposits are worked. Rock containing less than 40 per cent of sulphur is seldom mined.

The following information may be given with reference to the localities where sulphur is found. Sulphur deposits are found in the volcanic zone stretching from Formosa to the Kurile Islands. In addition, therefore, to the localities specifically mentioned it is found in Kyushu, Honshu, and Hakkaido. In the vicinity of Mount Daiton, Formosa, it is mined at several localities, the most important of which is Hokuto. In Kyushu a few mines are located near the volcano Kirishima, among which are those known as Sulphur Island and Kujusan. In the northern part of Honshu several occurrences are known along the Japan Sea, the most important producing mines here being Numajiri, Tsurugizan, and Uguisuzawa. The most important mines operating now in Hakkaido are Oshino, Kobui, Iwaonupuri, Kumadomari, and Shikabe. Several producing localities are known also in the Kurile Islands.

The greater part of the sulphur is directly traceable to solfataric action. At the Asada and Kobui mines, in Hakkaido, there are being mined deposits of clayey sulphur, deposited in an old crater lake. The sulphur is compact and gray or yellowish gray in color and is 50 to 90 per cent pure, the remainder being clay. The deposits are thin bedded, containing thin interstratified layers of tuff, which contain fossil leaves at rare intervals.

The production of sulphur from the principal mines in Japan in 1908 was 30,477 long tons, and in 1907 the production from these mines was 29,498 long tons. The domestic consumption of sulphur is very small, and almost the entire output is exported, chiefly to America, Australia, and China.

OTHER COUNTRIES.

Sulphur also occurs in the following countries, but in many of the places mentioned the deposits have little or no commercial value at the present time:

Europe.—Russia: The Caucasus, Transcaspian Territory; Austria-Hungary: Croatia; Galicia; Greece; southern France; Spain.

Asia.—Asia Minor, Baluchistan, Palestine, Persia, Philippines, Siberia.

Africa.—Algeria, Kamerun, Morocco.

Oceania.—New Hebrides: Tanna, Vanua Lava.

North America.—Mexico.

South America.—Chile, Peru.

USES OF SULPHUR.

Sulphur takes fire at a low temperature, and for this reason it is extensively used as a means of producing fire in friction matches, powder, and fireworks. It is employed also in the production of various sulphurous and sulphuric acids, in ultramarine, and in carbon disulphide. Wool, silk, sponges, and other materials are bleached with sulphur in the form of sulphur dioxide (SO_2). Wine casks, preserves, and other materials are treated with sulphur as a preservative. Rubber is also vulcanized with it. Sulphur in the form of sulphur dioxide is used in extinguishing chimney fires.[3] Sulphur is also used in medicine. The agricultural industry consumes large quantities of sulphur. It is used in this industry in spraying grapevines to protect them from certain fungous diseases.

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[1] Mining in Japan, past and present, Bur. Mines Japan, 1909.

[2] Stutzer questions this origin, and the translator thinks there is ample cause for the query.

[3] This gas has been suggested as a means of combating mine fires. See Snelling, W. O., Trans. Am. Inst. Min. Eng., vol. 39, 1908, pp. 550–552.

PRODUCTION OF CRUDE SULPHUR.

Crude sulphur is produced chiefly from ordinary sulphur ore; also from pyrite and from the calcium sulphide waste of the Le Blanc soda process; rarely from sulphurous acid (SO_2), hydrogen sulphide, gypsum, and other materials.[1] The method of obtaining it from its ore consists either of simple melting at low temperatures, or of distillation and sublimation at higher temperatures. In some places—e. g., for example, at Swoszowice, Galicia—extraction with carbon disulphide (CS_2) is successfully practiced. In places in Sicily the richest sulphur ore is melted in retorts. The temperature of the sulphur in this process should be raised but slightly in excess of the melting point, so that the sulphur may remain as fluid as possible and still not burn. The barren rock is fished out in ladles. This method was formerly practiced in Lercara with very rich ores. Another method, now abandoned, consists in piling up the sulphur ore in great heaps and setting fire to it. The sulphur which accumulates at the bottom is collected in shallow pools or basins. By this method only 33 per cent of the sulphur is extracted and at the same time the vegetation of the surrounding region is completely destroyed by the vapors emitted. The common practice at present in Sicily consists in melting the sulphur in so-called calceroni. The duration of the process depends on the character and amount of the ore and on climatic conditions. With dense, impermeable ore, cold weather, rain, and light winds, the melting process is of longer duration than when the opposite conditions prevail. A calcerone of 200 cubic meters content will burn a month; one with a content of 700 cubic meters two months, etc.

In recent years the calceroni are being replaced more and more by cell ovens. Each six cells constitutes a ring-shaped battery, and each cell holds from 5 to 30 cubic meters of ore. The gases pass from one cell to the next. The advantages of this method are a larger yield, namely, 50 per cent more than formerly, a small quantity of gases and consequently less destruction to surrounding vegetation, and a briefer duration of the whole process (three to four days for each cell).

The sublimation and distillation of the sulphur in closed vessels requires more fuel, but prevents the formation of sulphurous acid and yields a larger return. The apparatus employed in the process consists of very primitive earthenware pots or retorts, or refining furnaces, or kettles. In recent years superheated steam is used to melt the sulphur.

For the methods of obtaining sulphur from the metallic sulphides and other substances the reader is referred to the dictionaries on chemical technology.[2] The crude sulphur produced in the manner indicated above must be further refined to obtain pure sulphur. This is brought about either by simply remelting or by volatilization. In the latter case by properly cooling the condensation chambers the refined sulphur is obtained either in the liquid or the powdered form.

ARTIFICIAL PRODUCTION OF SULPHUR.

The question of the possibility of obtaining sulphur from certain raw materials may be briefly considered, since it has a certain interest in connection with the origin of sulphur deposits. Thus, first of all, pyrite and chalcopyrite when heated in the absence of air yield sulphur. As a result of this heating, the pyrite is converted into a modification of pyrrhotite.

Sulphur is also formed when sulphur dioxide is led over carbon (charcoal) heated to redness. The reaction is $SO_2+C=S+CO_2$, or $SO_2+2C=2CO+S$; or when sulphur dioxide is reduced by hydrogen thus: $SO_2+4H=2H_2O+S$. Finally, sulphur is obtained when sulphur dioxide is led over the glowing sulphides of the alkalies or alkaline earths.

Sulphur is obtained by burning the hydrogen contained in hydrogen sulphide. The combustion may take place either with free or combined oxygen. It is usually performed by means of a contact reaction, in which iron oxide is the medium employed. The following reaction is known to occur under moist conditions: $SO_2+2H_2S=2H_2O+3S$.

Many attempts have been made to produce sulphur from gypsum or barite. The sulphates were first reduced to the sulphides, from which hydrogen sulphide was liberated by carbonic or other acids. From the hydrogen sulphide the sulphur was obtained by known chemical methods.

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[1] Compiled principally from Muspratt, Encyklopädisches Handbuch der technischen Chemie, 4th ed., vol. 7, Braunschweig, 1900, p. 1012.

[2] See Muspratt, op. cit., p. 1025.

PYRITE.

PRODUCTION.

The production of pyrite in the United States in 1910 was less than in 1909; it amounted to 238,154 long tons, valued at $958,608, as compared with 247,070 long tons, valued at $1,028,157, in 1909, a decline of 8,916 long tons in quantity and of $69,549 in value. The falling off in the pyrite industry was due to diverse causes in different parts of the country. The same States produced pyrite in 1910 as in 1909, with the exception of Alabama and Pennsylvania, though the latter State has never been an important producer. The absence of Alabama from the list of producing States, the curtailment of the production of California and of Georgia, the decrease in the Massachusetts production, due to the cave-in at the old Davis mine near Charlemont, and the falling off in Ohio, due to strikes at the coal mines, have all contributed to the slight decline in the production of pyrite. Virginia gained notably both in quantity and in value of output, but not enough to make up for the losses in the States first mentioned. 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, 1908–1910, by States, in long tons.

State.	1908			1909			1910		
	Quantity.	Value.	Average price per ton.	Quantity.	Value.	Average price per ton.	Quantity.	Value.	Average price per ton.
Alabama and Georgia	23,915	$69,635	$2.91	15,848	$77,291	$4.88	(a)	(a)	......
California	30,545	131,744	4.31	51,266	254,235	4.96	23,700	$110,134	$4.65
Illinois and Indiana	4,905	14,157	2.89	8,332	23,046	2.77	10,502	33,747	3.21
Massachusetts and New York	b 40,362	186,126	4.61	c 47,987	c 221,299	4.61	38,978	187,071	4.80
Ohio	6,531	19,929	3.05	9,461	29,003	3.07	3,766	12,831	3.41
Pennsylvania	......	......	......	(d)	(d)	......	......	......	......
Virginia	116,340	435,522	3.74	114,176	423,283	3.71	e 148,653	e 565,358	3.80
Wisconsin	(d)	(d)	......	(d)	(d)	......	12,555	49,467	3.94
Total	222,598	857,113	3.85	247,070	1,028,157	4.16	238,154	958,608	4.03

a No production for Alabama; Georgia production included with Virginia.
b Includes the production of Wisconsin.
c Includes the production of Pennsylvania and Wisconsin.
d Included with Massachusetts and New York.
e Includes the production of Georgia.

Production of pyrite in the United States, 1882–1910, in long tons.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
1882	12,000	$72,000	1897	143,201	$391,541
1883	25,000	137,500	1898	193,364	593,801
1884	35,000	175,000	1899	174,734	543,249
1885	49,000	220,500	1900	204,615	749,991
1886	55,000	220,000	1901	a 241,691	1,257,879
1887	52,000	210,000	1902	a 207,874	947,089
1888	54,331	167,658	1903	a 233,127	1,109,818
1889	93,705	202,119	1904	207,081	814,808
1890	99,854	273,745	1905	253,000	938,492
1891	106,536	338,880	1906	261,422	931,305
1892	109,788	305,191	1907	247,387	794,949
1893	75,777	256,552	1908	222,598	857,113
1894	105,940	363,134	1909	247,070	1,028,157
1895	99,549	322,845	1910	238,154	958,608
1896	115,483	320,163			

a Includes production of natural sulphur.

PYRITE INDUSTRY BY STATES.

California.—California ranked third in 1910 in the production of pyrite, being exceeded by Virginia and New York. The output of the State fell off greatly from that reported for 1909, and was the lowest figure from this State for several years. California pyrite comes from near Oakland and Fruitvale, Alameda County, and from near Keswick, Shasta County.

Georgia.—The production of pyrite in Georgia was considerably less in 1910 than in 1909. The Georgia pyrite came from Villa Rica, Carroll County, about 30 miles west of Atlanta. The pyrite properties near Acworth, Cherokee County, were idle throughout the year.

Illinois.—The production of pyrite in Illinois in 1910 greatly exceeded the output of this State in 1909. The figures for 1910 show an increase of 53 per cent in quantity of pyrite produced, and of 60 per cent in value, as compared with the preceding year. Illinois now ranks fifth among the States in the production of pyrite, which is obtained as a by-product in the mining of coal.

Indiana.—The quantity of pyrite produced in Indiana was less in 1910 than in 1909. The value of the material reported, however, showed a slight increase. In Indiana the pyrite is obtained in mining coal.

Massachusetts.—The production of pyrite in Massachusetts is still falling off. The only producer, the Davis Sulphur Ore Co., is not operating the old Davis mine, which for many years has furnished the only pyrite reported from this State, but are simply "cleaning up" the property. The only shipments that are being made at the present time (January, 1911) from Charlemont, the nearest railroad connection, are concentrates obtained from milling the waste dumps. The methods of treating the low-grade ore from the dumps were outlined in this report for 1909, to which the reader is referred for more complete information.

New York.—The St. Lawrence Pyrite Co. was the only producer in New York in 1910. The mine of the company is located near Stellaville, St. Lawrence County.

Ohio.—The production of pyrite in Ohio in 1910 showed a marked falling off compared with the preceding year. Ohio pyrite is obtained in connection with the mining of coal, and owing to a strike many of the pyrite-producing coal mines were closed more than half the year.

Virginia.—As heretofore, Virginia led in the production of pyrite in 1910, the output of the State greatly exceeding in both quantity and value the returns for 1909. The pyrite is mined principally in Prince William, Louisa, and Pulaski counties. In this report for 1909 extended descriptions were given of the more important operations at these localities, and the reader is referred to that publication for details. A small output of pyrite was reported in 1910 from Garrisonville, Stafford County, south of Prince William County. Near Delwyn, Buckingham County, prospecting has been carried on in a recently discovered body of pyrite. A shaft 65 feet deep has been sunk and a well-defined ore body 11 feet in width was encountered. The gossan has been trenched for about 800 feet along the outcrop. Like the other Virginia pyrite, the material occurs in lens-shaped masses rather than in well-defined veins, the lenses conform-ing with the foliation or schistosity of the country rock. The ore body is capped with a considerable thickness of brown hematite. The latter is massive and granular and varies from fine to moderately coarse grained. The pyrite deposits of both Stafford and Buckingham counties are in the line of strike of the important pyrite deposits of Prince William and Louisa counties, a condition which ought to prove of interest and encouragement to prospectors or to prospective buyers.

Wisconsin.—Wisconsin is becoming an important producer of pyrite. The pyrite is obtained through separation from zinc blende by electrostatic methods which have been described in a former volume of "Mineral Resources." [1]

IMPORTS.

The importation of pyrite still greatly exceeds the domestic supply, as appears from the following table:

Imports of pyrite containing not more than 3.5 per cent of copper, 1906–1910, in long tons.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
1906	598,078	$2,148,558	1909	688,843	$2,428,580
1907	627,985	2,581,787	1910	803,551	2,748,647
1908	668,117	2,624,339			

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 market, estimated on the assumption that the pyrite averages 45 per cent sulphur:

World's production of iron pyrite and quantity of sulphur displaced, 1905–1909, in long tons.

Country.	1905	1906	1907	1908	1909
Spain	176,258	186,262	222,274	259,308	(a)
France	262,907	261,084	278,214	280,233	268,701
Portugal [b]	346,928	345,222	359,413	c 80,135	(a)
United States	253,000	261,422	247,387	222,598	247,070
German Empire	182,448	193,869	193,259	216,000	195,866
Norway	159,461	194,770	c 232,321	c 264,891	(a)
Greece				6,759	(a)
Hungary	105,165	110,849	97,936	97,268	(a)
Italy	115,814	120,437	c 124,926	c 129,647	129,921
Canada	29,236	35,365	c 41,288	c 42,264	57,718
Newfoundland	50,720	28,132	19,920	(a)	(a)
Russia	(a)	20,344	21,551	(a)	(a)
Servia				32,211	(a)
Turkey	d 12,697	d 34,449	d 62,008	e 57,707	(a)
United Kingdom	12,186	11,140	10,194	9,448	8,429
Bosnia and Herzegovina	18,745	13,262	7,115	10,238	(a)
Belgium	961	894	391	351	211
Sweden	20,435	21,483	26,686	29,103	(a)
Japan	25,165	3,540	55,281	33,334	(a)
Total	1,772,126	1,842,524	2,000,164		
Sulphur displaced [f]	797,457	829,136	900,074		

[a] Statistics not available.
[b] Includes cupreous iron pyrites.
[c] Cupreous iron pyrites.
[d] Exports.
[e] Year ending March, 1908.
[f] Based on estimated 45 per cent of sulphur content.

[1] Siebenthal, C. E., Mineral Resources U. S. for 1908, pt. 1, U. S. Geol. Survey, 1909, pp. 256-257.

THE CONSUMPTION OF SULPHUR IN THE UNITED STATES.

The consumption of sulphur in the United States for the years 1908, 1909, and 1910, in long tons, is given in the following table:

Consumption of sulphur in the United States, 1908–1910, in long tons.

Source.	1908	1909	1910
Domestic sulphur and sulphur content of pyrite	469,613	350,494	362,703
Imported sulphur	21,136	30,589	30,833
Sulphur content of imported pyrite[a]	300,653	309,979	361,598
Total domestic consumption	791,402	691,062	755,134

[a] Based on average sulphur content of 45 per cent.

BARYTES AND STRONTIUM.

By Ernest F. Burchard.

BARYTES.[1]

PRODUCTION.

The production of crude barytes in the United States in 1910 amounted to 42,975 short tons, valued at $121,746, as compared with 61,945 short tons, valued at $209,737, in 1909, a decrease in quantity of 18,970 tons and in value of $87,991. The average price per ton as reported to the Survey was $2.83 in 1910, as compared with $3.39 in 1909. The price so reported represents the price paid the miner for his crude ore, hand cobbed, sorted, and ready for shipment to the mills. This value is not intended to include the cost of any wagon, boat, or railway haulage, and it would appear that the 1910 figures have been reported more nearly on this basis than in the preceding two or three years. The price per ton delivered at railway points in Washington County, Mo., has ranged between $4.10 and $4.50 the last two years. At the close of 1910 there were 5,888 short tons of crude domestic barytes unsold at the mines, according to reports from the producing districts, as compared with 3,376 tons in 1909. In Missouri an output was reported by 48 producers, but in most cases the quantities were very small. In Kentucky, Tennessee, and Virginia there were 2 active producers in each State, and in Georgia and North Carolina there was 1 producer each. In California, Idaho, and Nevada there are promising deposits of barytes, and production is reported to have begun in California. The total quantity of refined barytes reported as sold by mills in Kentucky Missouri, North Carolina, Tennessee, and Virginia in 1910 was 38,165 short tons, valued at $475,001, as compared with 34,673 short tons, valued at $455,506, in 1909. This does not include barytes treated chemically or the production of barium salts. The average price per ton reported as received for refined barytes in 1910 was $12.44, as compared with $13.14 in 1909. The wholesale prices for refined barytes per short ton quoted by New York dealers toward the close of 1910 were as follows: "American ground," $12 to $15, and "floated," $17 to $19; "foreign floated," $20 to $23. The average wholesale price in New York for American ground barytes in 1910 was $13.50, compared with $14.75 in 1909.

Production of refined barytes was reported by one mill in each of the States of Kentucky, North Carolina, Tennessee, and Virginia, and by three mills in Missouri.

[1] For discussions of the occurrence and character of barytes in the United States and Canada see chapters on Barytes and strontium in 1906 and 1907 by Ernest F. Burchard in Mineral Resources of the United States for 1906 and 1907.

The following table gives the production of crude barytes in the United States from 1908 to 1910, by States, and shows the average price per ton in the producing localities:

Production of crude barytes in the United States, 1908–1910, by States, in short tons.

State.	1908			1909			1910		
	Quantity.	Value.	Average price per ton.	Quantity.	Value.	Average price per ton.	Quantity.	Value.	Average price per ton.
Kentucky	5,233	$21,504	$4.11	(a)	(a)	....	(a)	(a)	....
Missouri	16,319	56,768	3.48	34,815	$119,818	$3.44	22,978	$75,598	$3.29
North Carolina	(a)	(a)	....	(a)	(a)	....	(a)	(a)	....
Tennessee	8,618	12,313	1.43	(a)	(a)	....	4,729	7,281	1.54
Virginia	(a)	(a)	....	(a)	(a)	....	(a)	(a)	....
Other States [b]	8,357	29,857	3.51	27,130	89,919	3.31	15,268	38,867	2.55
Total	38,527	120,442	3.13	61,945	209,737	3.39	42,975	121,746	2.83

[a] Included in other States.
[b] Includes 1908, Georgia, North Carolina, and Virginia; 1909, Georgia, Kentucky, North Carolina, Tennessee, and Virginia; 1910, Georgia, Kentucky, North Carolina, and Virginia.

The following table gives the domestic production of crude barytes in short tons from 1882 to 1910, inclusive:

Production of crude barytes, 1882–1910.

Year	Short tons.	Year	Short tons.
1882	22,400	1897	26,042
1883	30,240	1898	31,306
1884	28,000	1899	41,894
1885	16,800	1900	67,680
1886	11,200	1901	49,070
1887	16,800	1902	61,668
1888	22,400	1903	50,397
1889	21,460	1904	65,727
1890	21,911	1905	48,235
1891	31,069	1906	50,231
1892	32,108	1907	89,621
1893	28,970	1908	38,527
1894	23,335	1909	61,945
1895	21,529	1910	42,975
1896	17,068		

IMPORTS.

The Payne-Aldrich tariff increased the duty on raw barytes imported from foreign countries from 75 cents 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 in the duty of half a 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. It has been reported that much of the so-called witherite that is imported, purporting to be ground natural barium carbonate, is probably precipitated barium carbonate.

It is of interest to note that during 1909, the first year of the operation of the increased duty on raw or unmanufactured barytes, there was a small decrease in the importations as compared with 1908, but in 1910 the imports increased more than 91 per cent, or from 11,647 short tons in 1909 to 21,270 short tons in 1910. The value per ton of the imported material decreased both in 1909 and 1910. The greater part of the imported barytes is obtained from Germany.

The imports of barytes for consumption during the last five years and the value of the imports of barium compounds during the last three years are shown in the following two tables:

Barytes imported and entered for consumption in the United States, 1906–1910, in short tons.

Year.	Manufactured.		Unmanufactured.		Total value.
	Quantity.	Value.	Quantity.	Value.	
1906	4,807	$37,296	9,190	$27,584	$64,880
1907	11,207	96,542	20,544	76,883	173,425
1908	3,401	29,168	13,661	58,822	87,990
1909	3,016	25,679	11,647	29,028	54,707
1910	3,565	29,782	21,270	48,457	78,239

Value of the imports of barium compounds, 1908–1910.

Barium compounds.	1908	1909	1910
Witherite, barium carbonate	$22,159	$31,584	$25,229
Barium binoxide	181,533	255,013	341,631
Barium chloride	42,291	47,352	35,614
Blanc fixe, or artificial barium sulphate	73,131	65,427	67,975
Total	319,114	399,376	470,449

PRODUCTION OF BARYTES IN CANADA.

According to the preliminary report on the mineral production of Canada for 1910 the revised figures of production for 1909 show that in 1909 there were 179 short tons of barytes produced in Canada, valued at $1,120. No statistics are given as to the production of barytes in 1910, except a reference to 5 hundredweight having been exported, valued at $150.

USES OF BARYTES

Barytes, barium sulphate ($BaSO_4$), is a heavy crystalline mineral, white when pure, and is very stable in relation to acids, alkalies, or corrosive gases. It is usually more or less iron stained and associated with clay, silica, calcium carbonate, and other minerals when mined, so that it has to be ground, washed, and bleached with acid to purify it. By far the greater part of the barytes produced is consumed in the ground, or ground, floated, and bleached state in the manufacture of mixed paints. It is not satisfactory as a pigment if used alone in oil, for its crystalline nature renders it too transparent to give good hiding power, and it must be used in only moderate percentages in mixed paints which consist principally of the lead and zinc-white pigments in order that advantages may be secured by its use. Its use as an adulterant in white lead, or in any other pigment or commodity, is not legitimate, and should be discouraged by the producers. There are sufficient legitimate uses for this valuable mineral to create a healthy market for it if properly handled. Barytes is used also in the manufacture of lithopone, a very white pigment that is suited most particularly to interior use in the manufacture of enamels and wall finishes. In the manufacture of lithopone barytes is first reduced from the sulphate to the sulphide of barium, and then treated with zinc sulphate. Zinc sulphide and barium sulphate, intimately mixed, is the result, forming lithopone. Barium sulphate is also obtained in the precipitated form (blanc fixe) which is used as a base on which lake colors are precipitated. Barium salts are reported to be used in brickmaking in order to overcome the efflorescence of bricks.

Other uses for barytes are in the manufacture of rubber, wall paper, asbestos cement, poker chips, and in tanning leather.

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STRONTIUM.

No strontium ore is reported to have been produced in the United States in 1910. The only importation of strontium salts reported by the Bureau of Statistics in 1910 was strontium monoxide or strontia, valued at $23, as compared with imports valued at $270 in 1909.

MINERAL PAINTS.

By Ernest F. Burchard.

GROUPS OF MINERAL PAINTS.

The mineral paints considered in this chapter are arranged in three groups: (1) Natural pigments, consisting of natural mineral products which after mechanical treatment, such as cleaning and grinding are either used directly as pigments or are first roasted to give certain desired colors; (2) pigments made directly from ores of valuable metals; and (3) chemically manufactured pigments, consisting of products that pass through several metallurgical and chemical processes in their preparation from the original ores.

Group 1 comprises ocher, umber, sienna, hematite, siderite, limonite, ground slate and shale, and whiting (ground limestone.) The three ores of iron, hematite, siderite, and limonite are the principal bases of metallic paints and mortar colors. Many other minerals or mineral products are used in the paint trade, such as asbestos and its derivatives, asphalt, barytes, clay, graphite, gypsum, magnesite, pyrite, shells, silica, and talc, and many by-products, but these are not considered here, since most of them are reported elsewhere in this volume, and for others statistics are not available.

Group 2 comprises zinc oxide, leaded zinc oxide, zinc-lead, sublimed white lead, and sublimed blue lead.

Group 3 comprises the chemical products, basic carbonate white lead, litharge, red lead, orange mineral, lithopone, and Venetian red. Collection of the statistics of production of the pigments and colors made by treating a mineral base with organic dyes does not come within the scope of this work. The quantity and value of the original minerals entering into their composition has, in most cases, been included elsewhere, so that the publication of the statistics of the manufactured products, including the value of the organic colors, would not only result in duplication of original quantities but would give greater than proportionate values to the minerals concerned. Collection of the statistics of production of pigments belonging to group 3 is undertaken chiefly for purposes of comparison, since the production of the ores and metals from which these pigments were derived is also reported elsewhere in Mineral Resources.

This grouping has reference particularly to the origin of the materials, and it is not intended to be a commercial classification. The total value of the lead and the zinc white pigments is enormously greater than that of the natural pigments. Lead and zinc white pigments form the bases for the greater part of all the standard paint manufactured at present.

NATURAL MINERAL PAINTS.

PRODUCTION.

The total production of natural mineral pigments in 1910 as reported to the survey was 68,623 short tons, valued at $527,795, as compared with 60,220 short tons, valued at $567,028, in 1909, an increase in quantity of 8,403 tons and a decrease in value of $39,233. The decrease in price per ton at the point of production was general for all the members of the group, ocher, umber and sienna, metallic paint, mortar colors, and ground slate and shale. The increase in quantity was shared by metallic paint and ground slate and shale, but all the other materials showed a decrease in quantity, as will appear from the discussion of the various pigments below.

The following table indicates the range in production of the natural pigments during the last four years:

Production of natural mineral pigments, 1907–1910, in short tons.

Kind.	1907		1908		1909		1910	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Ocher	14,354	$153,417	14,696	$140,439	12,458	$125,349	11,711	$112,445
Umber / Sienna	545	11,304	1,212	30,705	1,276	33,472	1,015	26,700
Metallic paint	15,048	181,693	14,022	156,694	20,722	201,905	29,422	184,869
Mortar colors	9,490	97,719	7,856	72,881	10,820	108,126	9,960	107,780
Slate and shale, ground	12,702	92,130	12,617	93,181	14,944	98,176	16,515	96,001
Total	52,139	536,263	50,403	493,900	60,220	567,028	68,623	527,795

OCHER.

Character.[1]—Ocher is a hydrated ferric oxide permeating a clay base. It has a specific gravity of about 3.5, and a decidedly golden-yellow color. Good grades of ocher contain 20 per cent or more of iron oxide. The particles of ocher as seen under a microscope are flocculent and present a uniform appearance.

Uses.—Ocher is used as a coloring matter for tinted paints and paints made with it as a base are often used for priming coats. It finds its most extensive use, however, as a filler in the manufacture of linoleum. Ferruginous shale is often ground and the product marketed as ocher, but unless the material is actually an ocher as defined above such product is classed under slate and shale in this chapter.

Sources.—Ocher is produced principally in Georgia, Pennsylvania, and Vermont, small quantities being reported from California, Kentucky, Iowa, and Virginia. More than half as much ocher as was produced in the United States was imported from France and other countries in 1910.

Production.—The production of ocher in 1910 was 11,711 short tons, valued at $112,445, as compared with 12,458 short tons, valued at $125,349, in 1909, a decrease in quantity of 747 tons and in value

[1] The commercial definitions of ocher, umber, and sienna in this chapter correspond to those published by the scientific section of the Paint Manufacturers' Association of the United States, Bull. 30, 1910.

of $12,904. The average price per ton in 1910 was $9.60, as compared with $10.06 in 1909, a decrease of $0.46 per ton.

The following table gives the production of ocher by States from 1907 to 1910:

Production of ocher, 1907–1910, by States, in short tons.

State.	1907		1908		1909		1910	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
California	450	$3,970	335	$2,250	(a)	(a)	118	$1,730
Georgia	5,600	57,100	6,035	63,851	5,838	$60,971	7,011	70,388
Pennsylvania	5,430	65,491	6,963	63,035	4,137	45,472	3,642	32,254
Vermont	682	6,638	188	2,050	492	4,726	609	5,935
Other States [b]	2,192	20,218	1,175	9,253	1,991	14,180	331	2,138
Total	14,354	153,417	14,696	140,439	12,458	125,349	11,711	112,445

[a] Included in "Other States."
[b] Includes, 1907 and 1908, Iowa, Kentucky, and Virginia; 1909, California, Iowa, and Virginia; 1910, Iowa, Kentucky, Oregon, and Tennessee.

UMBER AND SIENNA.

UMBER.

Character.—Umber consists of silicates of iron and aluminum containing varying proportions of manganic oxide, its color varying according to the percentages of the latter present. The color of raw umber is drab, which is changed to reddish brown by burning. This pigment generally contains a marked percentage of coarse particles, especially if raw.

Uses.—Umber is used principally as a pigment in the manufacture of tinted paints.

Sources.—Pennsylvania is the principal source of the domestic supply of umber, which at present is rather small, since more than four times the quantity produced in the United States is imported from Turkey and other countries.

SIENNA.

Character.—Sienna, like umber, is essentially composed of silicates of iron and aluminum, containing manganic oxide. It contains a lower percentage of manganic oxide than umber, and is of a lighter color. The raw pigment is found to contain many coarse particles, but fewer are present in the burned variety.

Uses.—Sienna is used principally as a pigment in paint manufacture.

Sources.—Sienna is produced in the United States principally in Pennsylvania, minor quantities being reported from time to time from Tennessee, Maryland, New York, and the Pacific coast. From two to three times the quantity of the domestic product is annually imported from foreign countries.

Production of umber and sienna.—The total quantity of umber and sienna produced in the United States in 1910 was 1,015 short tons, valued at $26,700, as compared with 1,276 short tons, valued at $33,472, in 1909, a decrease in quantity of 261 tons and in value of $6,772. The average price per ton of umber and sienna in 1910 was $26.31, as compared with $26.23 in 1909.

The following table gives the production of ocher and of umber and sienna in the United States from 1906 to 1910:

Production of ocher and of umber and sienna, 1906–1910, in short tons.

Year.	Ocher.		Umber and sienna.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1906	12,659	$135,834	542	$12,994	13,201	$148,828
1907	14,354	153,417	545	11,304	14,899	164,721
1908	14,696	140,439	1,212	30,705	15,908	171,144
1909	12,458	125,349	1,276	33,472	13,734	158,821
1910	11,711	112,445	1,015	26,700	12,726	139,145

IMPORTS.

The imports of ocher, umber, and sienna for the last five years are shown in the following three tables:

Imports of ocher, 1906–1910, in pounds.

Year.	Crude.		Dry.		Ground in oil or water.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
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
1910	181,176	2,055	11,849,921	129,308	10,213	483	12,041,310	131,846

Imports of umber, 1906–1910, in pounds.

Year.	Dry.		Ground in oil or water.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
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
1910	3,994,286	28,819	11,813	734	4,006,099	29,553

Imports of sienna, 1906–1910, in pounds.

Year.	Dry.		Ground in oil or water.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
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
1910	3,048,203	46,866	6,233	453	3,054,436	47,319

PRODUCTION IN PRINCIPAL COUNTRIES.

The following table gives the output of ocher and umber in certain of the principal producing countries from 1905 to 1909, inclusive, as far as statistics are available:

Production of ocher and umber in principal producing countries, 1905–1909, in short tons.

Year.	United States.		United Kingdom.		France.		German Empire (Bavaria and Saxony).	
	Quantity.	Value.	Quantity.[a]	Value.	Quantity.[b]	Value.	Quantity.	Value.
1905	11,296	$120,756	18,185	$75,238	41,667	$655,003	20,175	$40,369
1906	12,809	138,834	15,915	71,358	39,187	275,266	24,586	72,920
1907	14,575	157,711	16,455	70,117	36,217	423,830	1,679	5,290
1908	15,266	152,319	17,244	69,012	36,442	457,072	1,938	7,443
1909	13,064	138,553	18,271	73,873	36,971	419,321	....	....

Year.	Canada.		Belgium.		Japan.		Cyprus.	
	Quantity.[b]	Value.	Quantity.[b]	Value.	Quantity.[b]	Value.	Quantity.[c]	Value.
1905	5,105	$34,675	683	$2,084	23	$243	3,092	$6,817
1906	6,837	36,955	276	243	32	297	2,526	6,258
1907	5,828	35,569	220	876	331	2,531	7,301	20,279
1908	4,746	30,440	496	1,655	....	....	2,524	9,621
1909	3,940	28,093	771	1,351	....	....	....	....

[a] Includes oxides of iron and manganese used as pigments, lubricants, etc.
[b] Reported as ocher only.
[c] Umber exports.

METALLIC PAINT.

Character.—Metallic paint consists chiefly of red and brown iron oxides produced either by grinding natural iron oxides, either anhydrous or hydrated, or by roasting natural iron carbonate. The beds of Clinton hematite in New York, Tennessee, and Georgia, the Lake Superior red hematite in northern Michigan, and the gray siderite near Lehigh Gap, Pennsylvania, are the chief sources of the raw ore supply. Some red iron oxide is imported from Spain and from Persia. Several other materials are also used to an important extent in the manufacture of metallic paint. Blast-furnace dust, a grayish-brown dust composed of oxide of iron and coke that is separated at many furnaces, especially in the Pittsburg, Pa., district, yields on grinding a seal-brown powder. In the manufacture of sulphuric acid from iron pyrites, large quantities of "blue billy," a purplish oxide of iron not entirely free of sulphur, is produced, and this is ground to form a paint base. Ocherous silt deposited by water flowing from coal mines has been roasted to a bright red color and ground for paint material. Material of this description probably carries ferrous sulphate as well as hydrated ferric oxide. Another by-product that has been utilized as a metallic paint is the residue left after extracting aluminum salts from bauxite. It is apparently a ferruginous clay, which when roasted in a rotary kiln gives a brick-red granular material that is subsequently ground to a powder. This material is apt to retain appreciable quantities of soluble aluminum salts, which can hardly be considered as desirable ingredients in paint It is also reported that ferrous sulphate or copperas is roasted and sold as metallic paint, although copperas finds its chief use as a paint material in the manufacture of venetian red.

The metallic paints as considered here contain, therefore, both brown and reds. Commercially the browns are known as metallic brown and certain of the reds as Indian red. All the by-product substances can not strictly be classed in group 1, but, as a rule, the production of these materials is not reported to the Survey.

Production.—The production of metallic paint in 1910 as reported to the Survey amounted to 29,422 short tons, valued at $184,869, as compared with 20,722 short tons, valued at $201,905, in 1909, an increase in quantity of 8,700 tons, and a decrease in value of $17,036. One reason for the apparent decrease in value is that an effort has been made in tabulating the 1910 figures to put the production as nearly as possible on the basis of the production of the raw materials entering into the metallic paints. The production has been credited as far as possible to the respective States in which the material was mined. Owing to the fact that producers in Pennsylvania and Tennessee reported mainly in terms of dry ground paint, the average prices per ton for those States ran considerably higher than those for New York and other States where the material was sold mainly in the form of iron ore to paint mills. The maximum price—that of ground paint in Pennsylvania—was $11.37 per ton, and the minimum was $2.90, in New York, for crude Clinton iron ore selected for paint.

The following table gives the production of metallic paint from 1907 to 1910, inclusive:

Production of metallic paint, 1907–1910, by States, in short tons.

States.	1907		1908		1909		1910	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Maryland	(a)	(a)	(a)	(a)	431	$1,957	(a)	(a)
New York	2,159	$23,421	2,924	$28,090	2,553	25,533	[b] 11,085	$32,208
Pennsylvania	6,950	91,900	5,281	69,799	[c] 8,120	105,683	8,063	91,714
Tennessee	[d] 4,056	44,200	[d] 3,645	34,663	4,075	33,369	[d] 3,907	26,680
Other States [e]	1,883	22,172	2,172	24,142	5,543	35,363	6,367	34,267
Total	15,048	181,693	14,022	156,694	20,722	201,905	29,422	184,869

[a] Included in Tennessee.
[b] Principally crude iron ore sold for paint.
[c] Includes a small quantity of venetian red.
[d] Includes Maryland.
[e] Includes, 1907, California, Illinois, Ohio, Wisconsin; 1908, California, Ohio, Vermont, Virginia, Wisconsin; 1909, California, Michigan, Ohio, Vermont, Washington, Wisconsin; 1910, California, Georgia, Michigan, Missouri, Washington, and Wisconsin.

MORTAR COLORS.

Character.—In making mortar colors the dry-color makers utilize also a wide variety of materials, and as the mortar colors are marketed they are probably mostly mixtures. Some iron oxide is used in their production, some "blue billy" ore, considerable ground slate or shale, and considerable culm from coal washeries. The colors are various shades of red, brown, purple, blue, and black, and the material is used for tinting mortar, cement, and concrete.

Production.—The total quantity of mortar colors reported to the Survey as produced in 1910 amounted to 9,960 short tons, valued at $107,780, as compared with 10,820 short tons, valued at $108,126, in 1909, a decrease in quantity of 860 tons and in value of $346. The average price per ton in 1910 was $10.82, as compared with $9.99 in 1909. The material considered here was practically all sold in the dry-ground condition.

The following table gives the production of mortar colors from 1907 to 1910, inclusive:

Production of mortar colors, 1907–1910, by States, in short tons.

States.	1907		1908		1909		1910	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
New York	4,235	$47,350	4,124	$37,392	5,691	$53,539	5,200	$50,000
Pennsylvania	1,330	13,490	(a)	(a)	2,662	31,416	2,711	33,752
Other States [b]	3,925	36,879	3,732	35,489	2,467	23,171	2,049	24,028
Total	9,490	97,719	7,856	72,881	10,820	108,126	9,960	107,780

[a] Included in "Other States."
[b] Includes, 1907, Maryland, Ohio, Tennessee, Wisconsin; 1908, Maryland, Ohio, Pennsylvania, Tennessee, Wisconsin; 1909 and 1910, Maryland, Ohio, Tennessee.

SLATE AND SHALE.

Slate and shale were ground for use as pigments and as fillers in 1910 in Pennsylvania, New Jersey, New York, and Iowa, which ranked as producers in the order named. As a result of recent studies made by Prof. B. L. Miller, of Lehigh University, South Bethlehem, Pa., for the Pennsylvania and the United States geological surveys, much information not generally known concerning the extensive use and relative importance of ground slate and shale among the natural pigments has been published.[1] The following statement by Prof. Miller is, therefore, of interest in this connection:

For certain purposes pigments of low tinting value, such as colored shales, have been found to be equal to those of more uniform composition and deeper color. In the manufacture of oilcloth and linoleum the mineral coating on which the color patterns are printed and also the under surface can be prepared as well from yellow and red shales containing only a small percentage of iron as from yellow and red ochers in which the iron content is much higher. Similarly the paint that is applied to a fresh surface of wood or metal primarily for the purpose of filling the pores and small cavities in order to make a smooth surface on which later coats of paint are spread can be manufactured from materials with low tinting value. Black, red, and yellow shales are utilized for these purposes, and the materials when prepared for the market are known as paint fillers.

The mineral composition of the shales used as pigments is varied, but they are characterized by the absence of any minerals that readily decompose on exposure to atmospheric action. The minerals present must be inert and they must possess the desired color. The basis of all the shales is hydrated aluminum silicate (clay), together with considerable silica in the form of quartz, the whole colored by iron, either in the hydrated form (limonite) or in the anhydrous condition (hematite), by graphite or amorphous carbonaceous matter, by manganese oxide, or by some other colored constituents. Sericite is not uncommonly present and in many of the paint shales of Pennsylvania is a prominent constituent.

Besides the mineral composition it is necessary to determine the amount of linseed oil required for each pigment, as in the cheaper paints the oil costs much more than the dry colors, and the materials requiring the minimum amount of oil are preferred by the manufacturers of mixed paints. Many of the claims of superiority of one product over another are based on its lower absorption of oil.

[1] Miller, B. L., Paint shales of Pennsylvania: Bull. U. S. Geol. Survey No. 470-i, 1911, 15 pp.

The quarrying of the shales is a simple process and calls for no special descriptio The preparation of the materials for the market is simple in principle but deman considerable care, and several processes are utilized in the mills now operating Pennsylvania. The excess of water must be eliminated by drying and the shal ground to extreme fineness. The value of the pigment is to a considerable exte determined by its fineness.

The prices of the prepared pigments range from $3 to $50 a ton and depend c their adaptability for definite purposes and the supply available. As a rule th margin of profit is moderate and the market is limited, otherwise the annual pr duction would be greatly increased. Each company in operation could readil increase its output with a minimum of expenditure and would undoubtedly do s if the demand were greater. Although most of the ground shale produced in Penn sylvania is utilized by local paint and linoleum manufacturers, a considerable po tion is shipped to remote parts of the United States and even to foreign countries.

Production.—As a result also of Prof. Miller's investigations con siderable material formerly classed as ocher and as metallic paint i Pennsylvania has been reclassified, with reference to its origin a slate and shale. This reclassification has accordingly apparentl increased the production of slate and shale from 150 per cent to 30 per cent over that reported in former volumes of Mineral Resources The total quantity of slate and shale ground for pigment and fo fillers in linoleum, etc., in 1910 amounted to 16,515 short tons valued at $96,001, as compared with 14,944 short tons, valued a $98,176, in 1909, an increase in quantity of 1,571 tons and a decrease in value of $2,175. The average price per ton of the ground material in 1910 was $5.81, as compared with $6.57 in 1909.

The following table gives the revised production of slate and shale ground for pigments and fillers from 1907 to 1910, inclusive:

Quantity and value of slate and shale, ground for pigment, 1907–1910.

1907	short tons	12,702	$92,130
1908	do	12,617	93,181
1909	short tons	14,944	$98,176
1910	do	16,515	96,001

DISTILLED SHALE.

A small quantity of carbonaceous shale is distilled annually for use as paint. The material yields a dark oil and a black residue, both of which are used in paint manufacture. Production has thus far been reported from Illinois and Tennessee, and the range in annual sales is from about 100 to 600 tons, valued at about $22 per ton.

WHITING.

Character.—Whiting, or natural calcium carbonate, is prepared by grinding various forms of soft and hard white limestone and calcite, the crystalline form of this carbonate. Whiting, however finely ground, shows a crystalline nature under the microscope and contains many comparatively coarse particles. An artificial form is prepared by precipitating calcium carbonate, and thus prepared, it is finer and more even grained.

Use.—Whiting is largely used in the manufacture of putty and is contained in small percentages in many ready-mixed paints.

Production.—No attempt has heretofore been made by the survey to obtain the statistics of production of whiting, but as a result of a partial canvass of the field, it has been ascertained that at least 6,531 short tons of ground whiting were produced in 1910, valued at $76,731, or $11.75 per ton. This production was reported from California and Missouri, and there is reason to believe that if more complete statistics can be secured that a much larger production will be reported showing that Kentucky and other States are also producers.

PIGMENTS MADE DIRECTLY FROM ORES.

PIGMENTS AND ORES.

The relations to the ores from which they are derived of the various pigments that are made directly from ores are of interest here, and the following notes may serve to define the pigments and to outline their properties and the methods by which they are manufactured.

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, the Joplin district of Missouri, Kansas, and Oklahoma, and in southeast Missouri), and the sulphide, carbonate, and silicate ores of zinc and lead produced in Colorado and New Mexico.

ZINC OXIDE.

Zinc oxide is the most important of the zinc pigments. This substance is often known to the trade as zinc white, but there are at least three other white zinc pigments sometimes termed "zinc white," viz, leaded zinc oxide, zinc-lead, and lithopone.

Zinc oxide, represented by the formula ZnO, is a white powder consisting, by weight, of 80.34 per cent zinc and 19.66 per cent oxygen. It is produced by two methods—one known as the French, the other as the American process. In the French process metallic zinc is burned in a current of air, and the product of combustion, zinc oxide, is collected in closed chambers. In the American process ores of zinc mixed with finely powdered coal are burned in a closed furnace over a grate, and the product, zinc oxide, after passing through a series of cooling flues, is collected in cloth bags, which retain the white sublimate and permit the fumes to escape. When made from the metal the oxide is nearly chemically pure, but when made from the ore the oxide usually contains lead sulphate, zinc sulphate, and traces of iron and other metals.

The principal types of ore used for making zinc oxide are the franklinite ore of New Jersey, the sphalerite ores of the Mississippi Valley, and the sulphide, carbonate, and silicate ores of zinc and lead found in Colorado and New Mexico. There are plants producing the oxide from the ore at Newark, N. J., at Palmerton, Pa., at Mineral Point, Wis., at Joplin, Mo., and at Coffeyville, Kans. Leaded zinc oxide and zinc-lead white are made also at Canon City, Colo. The plant at Joplin, Mo., was built to use local ores, with bituminous coal as fuel. The high price of pure zinc ores led to the use of an ore which contained some lead, and as an outgrowth of this practice a smelter designed to treat complex western ores without separating them was built at Coffeyville, Kans., where natural gas is available for fuel. This plant is arranged in units so that one can be operated to make zinc oxide while another is making leaded zinc oxide or zinc-lead, or all the units can be employed in making one kind of pigment. The ores used are from Magdalena, N. Mex. They comprise sulphides, carbonates, and silicates of zinc and lead, and may be a combination of any of these, provided that the combined content of metallic zinc and lead is sufficiently high.

Natural gas is used in roasting the ore at the Coffeyville plant and Arkansas semianthracite coal is used in the oxidizing furnaces. In this process small quantities of copper, gold, and silver are recovered from the ores high in zinc, since they readily pass into the slag while the zinc is being volatilized.

Production.—The production of zinc oxide in 1910, as reported to the Survey, was 59,333 short tons, valued at $5,325,636, as compared with 68,974 short tons, valued at $6,156,755, in 1909. This represents a decrease of 9,641 short tons in quantity and of $831,119 in value. The reported average value per ton in 1910 was $89.76; that of 1909 was $89.26, an increase of 50 cents per ton in 1910.

ZINC-LEAD AND LEADED ZINC OXIDE.

Zinc-lead is a white pigment consisting apparently of a molecular combination of zinc oxide and lead sulphate, with small proportions of lead oxide, lead carbonate, and zinc sulphate. It is prepared by sublimation from low-grade zinc-lead ores. This pigment is very fine, amorphous, and uniform in size of its particles. It is not quite so white as zinc oxide.

Leaded zinc oxides are pigments that resemble zinc-lead, but contain less lead sulphate. They are made with definite percentages of lead sulphate, usually ranging from 6 to 20 per cent, according to the purpose for which they are to be used. These oxides are produced from western ores that carry a certain proportion of lead sulphide. In fineness they are similar to zinc oxide, and in whiteness they stand between zinc oxide and zinc-lead.

Production.—The production of leaded zinc oxide in 1910 was 7,111 short tons, valued at $644,930, as compared with 7,655 short tons, valued at $634,714, in 1909, a decrease of 544 short tons in quantity and an increase of $10,216 in value. In 1910 the average value per ton was $90.69; in 1909 it was $82.91, an increase in 1910 of $7.78 per ton.

SUBLIMED WHITE LEAD AND SUBLIMED BLUE LEAD.

Sublimed white lead is made directly from the lead ore, galena or lead sulphide, three firms having reported production in 1910. It is manufactured from ore produced in the Joplin (Mo.) district, and from southeast Missouri ores, by a process similar in principle to that employed for making zinc oxide and zinc lead. Briefly summarized, the method of manufacture is as follows: Lead ore (galena), after having been cleaned at the mine by crushing, washing, and jigging, is ground to a powder and charged with carbon into a furnace over an open coke fire. The charge is volatilized and in the presence of air the lead sulphide is oxidized to a basic lead sulphate, while some free sulphur dioxide is formed. The basic lead sulphate is thought to be composed of two molecules of lead sulphate ($PbSO_4$) linked to one of lead oxide (PbO). This product, volatile while hot, is cooled by being drawn by suction through a long series of cooling pipes, or goosenecks, and some settling chambers, and then is collected in bags of the type used for collecting zinc oxide. The aim is to produce a pigment containing 75 per cent of lead sulphate, 20 per cent of lead oxide, and 5 per cent of zinc oxide. Notable properties of this pigment are its great fineness, the uniform size of its particles, and its relative chemical stability or inertness in the presence of coal gas, sulphur fumes, and other noxious gases that quickly darken some paints. It has a snow-white color and is very opaque, but since it is so extremely fine and of amorphous texture it requires blending with coarser pigments to give it "tooth"—that is, to prevent it from brushing out too thin.

Sublimed white lead finds use not only in mixed paints, but in putty and in the manufacture of rubber.

In the sublimation of galena a peculiar bluish-gray compound of lead is formed as a by-product, which is known commercially as "sublimed blue lead." In the furnace it is known as "fume." Analyses have shown the presence in it of about 2 per cent carbon, 4.5 to 5 per cent lead sulphide, 1 to 2.5 per cent zinc oxide, 0.36 to 1.44 per cent lead sulphite, 50 to 53 per cent lead sulphate, and 37.5 to 41.3 per cent lead oxide.

Sublimed blue lead, besides being used in paint manufacture, is used in the rubber industry.

Production.—In 1910 there were produced in the United States 9,951 short tons of sublimed white lead, including a small production of sublimed blue lead, valued at $1,002,010, an average of $100.69 per ton; in 1909 the combined production amounted to 10,896 short tons, valued at $1,171,863, an average of $107.55 per ton. There was, therefore, a decrease in quantity in 1910 as compared with 1909 of 945 short tons, and a decrease in value of $169,853. The decrease in value per ton in 1910 as compared with 1909 was $6.86.

The following table gives the production of pigments made directly from ores from 1907 to 1910, inclusive:

Production of pigments made directly from ores, in short tons.

Pigment.	1907		1908		1909		1910	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Sublimed blue lead	1,211	$135,632	1,311	$121,923	981	$101,043	9,951	$1,002,010
Sublimed white lead	8,700	1,026,600	9,100	973,700	9,915	1,070,820		
Zinc-lead	13,516	1,286,440	[a]8,430	778,200	[a]7,655	634,714	[b]7,111	644,930
Zinc oxide	71,784	6,490,660	[c]56,292	5,072,460	68,974	6,156,755	59,333	5,325,636
Total	95,211	8,939,332	75,133	6,946,283	87,525	7,963,332	76,395	6,972,576

[a] Includes leaded zinc oxide.
[b] All leaded zinc oxide.
[c] Exclusive of 945 tons from foreign ores.

IMPORTS OF ZINC OXIDE.

The table following gives the imports of zinc oxide into the United States in the last five years.

Imports for consumption of zinc oxide, 1906–1910, in pounds.

Year.	Dry.		In oil.		Total.	
	Quantity.	Value.	Quantity	Value.	Quantity.	Valu
1906	4,191,476	$251,609	292,538	$36,457	4,484,014	$288,(
1907	5,311,318	323,551	362,814	33,679	5,674,132	357,[illegible]
1908	4,635,101	262,876	210,166	16,798	4,845,267	279,[illegible]
1909	6,119,328	342,999	535,024	54,085	6,654,352	397,(
1910	6,137,362	365,701	393,248	30,872	6,530,610	396,5

CHEMICALLY MANUFACTURED PIGMENTS.

PRODUCTION.

Under this heading are grouped the important lead pigments mad from pig lead and lead compounds, and such minor pigments a lithopone and Venetian red, both of which are chemically precipi tated from mineral salts. Much of the material now sold as Vene tian red, however, instead of being precipitated from ferrous sul phate and calcium hydroxide, is made in several ways, such as by calcining pyrite 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.

The total production of this group of pigments decreased in quantity from 211,687 short tons in 1909 to 208,098 short tons in 1910, and increased in value from $24,253,620 in 1909 to $24,799,092 in 1910.

BASIC CARBONATE WHITE LEAD.

Dutch process.—This pigment [1] is made by stacking clay pots which contain dilute acetic acid and lead buckles in tiers and covering them with tan bark. Fermentation of the tan bark with subsequent formation of carbon dioxide acting on the acetate of lead formed within the pots produces basic carbonate of lead. After complete corrosion, the white lead is ground, floated, and dried. Basic carbonate of lead has a specific gravity of 6.8 and contains about 85 per cent lead oxide and 15 per cent of carbon dioxide and water. Various sized particles, both large and small, resulting from the corrosion process are present. Its opaque nature and excellent body render it extremely valuable as a pigment, and its life and wearing properties are considered by many paint manufacturers to be increased when mixed with zinc oxide and many other pigments. Checking and chalking progress rapidly when the pigment is used alone.

Quick process.—The quick-process white lead is produced by the action on atomized metallic lead, contained within large revolving wooden cylinders, of dilute acetic acid and carbon dioxide.

Mild process.—Briefly, the mild process of manufacturing white lead consists of first melting the pig lead and converting it into the finest kind of lead powder, then mixing thoroughly with air and water. The lead takes up oxygen from the air and water, thus forming a

[1] Bull. Sci. Sec. Paint Mfrs. Asso. United States, No. 29, 1910, pp. 5–6.

basic hydroxide of lead. Carbon dioxide gas is next pumped slowly through the cylinders which contain the basic hydroxide of lead. The result is basic carbonate of lead—the dry white lead of commerce.

The process is called "mild" because it is the mildest process possible for the manufacture of white lead. The method does not require the use of acids, alkalies, or other chemicals, every trace of which should be removed from the finished product by expensive purifying processes.

Production.—The production of basic carbonate (corroded) white lead in 1910 as reported to the Survey was 144,565 short tons, valued at $18,485,890. This includes white leads produced by all three processes. Of this total, 111,573 short tons, valued at $15,027,993, were sold in oil, and 32,992 short tons, valued at $3,457,897, were reported sold dry. The sales for 1910 represented a net decrease from those for 1909 of 3,534 short tons in quantity, and an increase of $280,808 in value.

The average price per ton of basic carbonate white lead ground in oil was $134.69 in 1910, as compared with $127.85 in 1909, an increase of $6.84 per ton, and the average price of the dry white lead was $104.81 in 1910, as compared with $105.62 in 1909, a decrease of 81 cents per ton. The increase in lead ground in oil was, of course, due to a small degree to the increase in price of linseed oil.

RED LEAD.

By the continued oxidation of litharge[1] in reverberatory furnaces, red lead is produced as a brilliant red pigment. It has found wide application as an inhibitive pigment for the protection of iron and steel. In many cases the admixture of red lead with other pigments is of great value. The pigment particles appear to be of many sizes, showing a slight tendency to form a compact mass.

Production.—The production of red lead rose from 19,103 short tons, valued at $2,335,799, in 1909, to 19,833 short tons, valued at $2,453,014, in 1910, an increase of 730 short tons in quantity and of $117,215 in value. The average price per ton increased from $122.27 in 1909 to $123.68 in 1910, an increase of $1.41 per ton.

LITHARGE.

Litharge, or lead monoxide, is made directly by rapid oxidation of pig lead or by the oxidation of molten lead, or indirectly in the metallurgy of silver, and also from acetate of lead. Litharge is a buff-colored powder. It is used in paints, in glazes, and in storage batteries.

Production.—The production of litharge as reported to the Survey was 23,766 short tons, valued at $2,689,016, in 1910, as compared with 20,690 short tons, valued at $2,363,002, in 1909, an increase in quantity of 3,076 tons and in value of $326,014. The average price per ton was $113.15 in 1910, as compared with $114.21 in 1909.

[1] Bull. Sci. Sec. Paint Mfrs. Assoc. U. S., No. 29, 1910, p. 24.

ORANGE MINERAL.

Orange mineral is a form of red lead and is one of the higher oxid of lead. It is prepared by calcining a more or less basic carbonate lead. It is valued according to the depth and color of its brig orange shade.

Production.—The production of orange mineral as reported to th Survey was 823 short tons, valued at $136,082, in 1910, as compare with 590 short tons, valued at $98,723, in 1909. The apparent averag price per ton was $165.35 in 1910, as compared with $167.33 in 190

LITHOPONE.

Lithopone,[1] a very white pigment, is precipitated by the doub decomposition of zinc sulphate and barium sulphide, thereby formin an intimate mixture of zinc sulphide and barium sulphate. Th peculiar property which it possesses, of darkening under the actini rays of the sun, makes it essential that it be combined with othe more stable pigments to prolong its life when exposed to weathe Lithopone contains approximately 70 per cent barium sulphate, 2 to 28 per cent zinc sulphide, and as high as 5 per cent of zinc oxide Its specific gravity is about 4.25. It is excellently suited for interio use in the manufacture of enamels and wall finishes. When prop erly mixed with other pigments, such as zinc oxide and calcium car bonate, fair results are obtained as a pigment for outside work. Lea pigments are never used with lithopone, as lead sulphide results giving a black appearance. The characteristic flocculent, noncrys talline appearance is plainly evident when examined under th microscope.

Production.—The production of lithopone in 1910 was reported as 12,693 short tons, valued at $919,407, as compared with 14,847 short tons, valued at $1,105,281, in 1909, a decrease in quantity of 2,154 tons and in value of $185,874. The apparent price per ton in 1910 was $72.43, as compared with $74.44 in 1909.

VENETIAN RED.

Venetian red is made in different ways, such as by grinding red iron oxide with gypsum, or by roasting ferrous sulphate with lime and grinding the residue—in either case the red is a mixture of iron oxide and calcium sulphate—or by grinding red iron oxide with calcium carbonate, or by calcining pyrite and ferrous sulphate with terra alba, and in sundry other ways.

Production.—The production of Venetian red as reported to the Survey was 6,418 short tons, valued at $115,683, in 1910, as compared with 8,358 short tons, valued at $145,733, in 1909, a decrease in quantity of 1,940 tons and in value of $30,050. The apparent average price per ton was $18.02 in 1910 as compared with $17.44 in 1909.

The table following gives the production of these various chemically manufactured pigments and colors for the years 1907 to 1910, inclusive.

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[1] Bull. Sci. Sec. Paint Mfrs. Assoc. U. S., No. 29, 1910, p. 10.

Production of chemically manufactured pigments, 1907–1910, in short tons.

	1907		1908		1909		1910	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Basic carbonate white lead:								
In oil	92,216	$12,138,932	101,109	$12,552,771	115,259	$14,736,360	111,573	$15,027,993
Dry	35,035	4,309,392	31,479	3,338,830	32,840	3,468,722	32,992	3,457,897
Red lead	20,078	2,802,454	16,720	2,065,202	[a]19,103	2,335,799	[a]19,833	2,453,014
Litharge	20,838	2,854,987	15,542	1,887,506	20,690	2,363,002	23,766	2,689,016
Orange mineral	669	129,410	397	65,498	590	98,723	823	136,082
Lithopone	10,275	750,350	8,292	639,483	14,847	1,105,281	12,693	919,407
Venetian red	7,566	134,167	8,825	159,650	8,358	145,733	6,418	115,683
Total	186,677	23,119,692	182,364	20,708,940	211,687	24,253,620	208,098	24,799,092

[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 1906 to 1910, inclusive:

Basic carbonate white lead, red lead, litharge, orange mineral, and venetian red imported, 1906–1910, in pounds.

Year.	Corroded white lead.		Red lead.		Litharge.		Orange mineral.		Venetian red.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
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
1910	686,052	38,917	822,289	32,750	48,693	2,252	600,461	32,199	2,490,138	21,591

PAINT TESTS.

The study of protective coatings for structural materials, begun several years ago, was continued actively by the scientific section of the Paint Manufacturers' Association up to the middle of 1910, and later the work was continued by the Institute of Industrial Research, Washington, D. C. Inspection of the wooden and steel test fences at Atlantic City and of the wooden fence at Pittsburg, discussed more fully in the report for 1909, as well as of the steel plates on the Pennsylvania Railroad bridge at Havre de Grace, Md., were made in the spring of 1910 by representatives of the scientific section and of the American Society for Testing Materials, and reports of the findings have been published by both organizations, as listed in the bibliography at the end of this report, and the reader is referred to the respective publications for details as to the results of tests. Repainting tests were made in May, 1910, on the first set of panels painted originally in 1907, using paint that was part of the original supply and of the same composition as that used in the first painting in 1907. Subsequent inspections were made early in the summer of 1911.

The American Society for Testing Materials is planning a compre hensive series of tests of white paints, and the committee on the whit paint tests has developed the details of an exposure test which will b begun during 1911. These tests are to include seven single whit pigments, as follows: White lead, Dutch process; white lead, Carter or "quick" process; white lead, Acme or "mild" process; zinc oxid French process; zinc oxide, American process; sublimed white lea and zinc lead. Paints of binary, ternary, and quaternary compos tion are also to be made, and these mixtures will include, besides t seven pigments noted above, silica, asbestine, calcium carbonat calcium sulphate, and barytes. The mixtures of pigments a designed on the volume basis—that is, mixtures which are direct comparable contain the same relative volumes of different pigment For purposes of mixing, however, it is practically necessary to m the pigments by weight, therefore both the proportions by weight well as by volume will be recorded. The pigments are to be mixe with raw oil, to which is to be added a known quantity of lead a manganese driers. Sufficient oil is to be used to give a standa viscosity.

On September 15, 1910, the erection of a wooden test fence w completed on the State Fair Grounds, at Nashville, Tenn., by t scientific section of the Paint Manufacturers' Association. On th fence were exposed 42 samples of white paint in order to determi how the combination type of formula compares with the single pi ment paint under climatic conditions prevailing in the vicinity Nashville. Another important object was also kept in mind instituting this test, viz, the testing of paint oils other than lingsee such as soya bean oil, rosin oil, wood turpentines, and pine o Among the objects of the test fence is to interest the farmers of t Southern States in the growing of flax and other oil-bearing seed and in case the tests of the pine oil prove it to be worthy, to encoura southern manufacturers to produce this material in quantity fractional distillation of the crude spirits.

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ASBESTOS.[1]

By J. S. Diller.

INTRODUCTION.

The asbestos industry of the United States for 1910, at least as far as production is concerned, has steadily advanced notwithstanding the oscillations in prices and production in the neighboring and far greater field of Canada, which still continues to be the chief source of the raw material for our manufactories. In Canada a combination of interests resulted in stimulating production until it reached overproduction in the summer of 1910. Decline followed in both production and prices, but it is regarded as only temporary, for it is believed that more stable conditions will soon be reached.

PRODUCTION.

The total production for 1910 was 3,693 tons, valued at $68,357, which is an increase of 20 per cent in quantity and of 9 per cent in value over that of 1909. The domestic production in 1910 was only about 8 per cent of the quantity imported from Canada during the same year and manufactured in the United States. There are four producing States—Georgia, Idaho, Vermont, and Wyoming. Georgia and Idaho produce the amphibole variety and Vermont and Wyoming yield chrysotile.

Vermont and Georgia remain as in 1909 the chief producers of asbestos in the United States, with an increase of 23 per cent over that of 1909. The production of Wyoming and Idaho has advanced, but the industry is still in the development stage and has not become permanently established. The asbestos produced by Vermont and Wyoming being of the serpentine variety, chrysotile, is more valuable than that of Georgia and Idaho, and its production is increasing more rapidly. Chrysotile asbestos is adapted to a much wider range of uses than the amphibole variety and its field is still enlarging. The overproduction in Canada and consequent decline in prices must be felt to a considerable extent in the American mines and manufactures, but confidence in the future is indicated by the continued activity in enlarging plants to increase output.

The table following shows the quantity and value of the asbestos produced in the United States annually since 1890:

[1] The types, modes of occurrence, and important localities of asbestos in the United States are described in Bull. U. S. Geol. Survey No. 470, 1911.

Annual production of asbestos in the United States, 1890–1910.

Year.	Production.		
	Quantity (short tons).	Value.	Average price per ton.
1890	71	$4,560	$64.23
1891	66	3,960	60.00
1892	104	6,416	61.69
1893	50	2,500	50.00
1894	325	4,463	13.73
1895	795	13,525	17.01
1896	504	6,100	12.10
1897	580	6,450	11.12
1898	605	10,300	17.02
1899	681	11,740	17.24
1900	1,054	16,310	15.47
1901	747	13,498	18.07
1902	1,005	16,200	16.12
1903	887	16,760	18.90
1904	1,480	25,740	17.39
1905	3,109	42,975	13.82
1906	1,695	28,565	16.85
1907	653	11,899	18.22
1908	936	19,624	20.97
1909	3,085	62,603	20.29
1910	3,693	68,357	18.51

In view of general trade depression both here and abroad the prices of the higher grades have diminished 10 to 15 per cent, and the price of paper stock has diminished about 20 per cent, but the prices of the lower grades of fiber have advanced about 15 or 20 per cent, so that there is no great difference in the actual average values between 1909 and 1910.

IMPORTS.

Canada continues to be by far the most important source of the raw asbestos used in the United States, so that all other possible sources may be disregarded unless the industry shall be affected by the proposed reciprocity treaty with Canada. At present unmanufactured asbestos, including ground, is imported duty free. On woven fabrics whose value is made up wholly or chiefly of asbestos there is a duty of 40 per cent ad valorem. On all other forms of manufactured asbestos there is a duty of 25 per cent.

If the proposed reciprocity treaty [1] between the United States and Canada is ratified "asbestos not further manufactured than ground" will be free, but on "asbestos further manufactured than ground, manufactures of articles of which asbestos is the component material of chief value, including woven fabrics wholly or in chief value of asbestos" the duty will be "22½ per cent ad valorem."

The Canadian exports of asbestos during the 12 months ending December 31, 1910, are reported by the customs department of the Dominion [2] as 71,485 short tons, valued at $2,108,632. Of this, 57,939 short tons, valued at $1,505,477, were shipped to the United States—that is, over 81 per cent of all the asbestos exported by Canada, over 76 per cent of all that was shipped from her mines, and over 60

[1] A bill to promote reciprocal trade relations with the Dominion of Canada, and for other purposes: H. R. 22, 62d Cong., 1st sess., Apr. 4, 1911.

[2] Preliminary report on the mineral production of Canada during the calendar year 1910: Dept. Mines Canada: McLeisch, John.

per cent of all that was produced in 1910, including the large amounts held by the mines in storage.

The total quantity of all the asbestos unmanufactured imported into the United States in the calendar year 1910 was 52,888 long tons, or 59,235 short tons, valued at $1,235,171. The sources from which the imports are obtained are reported by the Bureau of Statistics of the Department of Commerce and Labor only for fiscal years. The imports during the fiscal year ended June 30, 1910, amounted to 47,510 long tons, equivalent to 53,211 short tons, valued at $1,122,085 as shown, with the sources from which obtained, in the following table:[1]

Value of free imports of unmanufactured (including ground) asbestos into the United States for the fiscal years ending June 30, 1908, 1909, and 1910.

	1908	1909	1910	
			Quantity (long tons).	Value.
Germany	$1,036	$11,031	43	$3,484
Italy	982	56	6	1,307
Russia in Europe		9,774	92	20,121
United Kingdom	48,038	20,623	47	10,075
Total for Europe	50,056	41,484	188	34,987
Canada	1,065,744	979,906	47,322	1,087,098
Grand total	1,115,800	1,021,390	47,510	1,122,085

The total value[1] of the manufactured asbestos imported during the year ending June 30, 1910, was $269,161, of which that from Canada was valued at $118, from Austria-Hungary $58,198, from Germany $76,459, and from the United Kingdom $121,355.

The value of the manufactured and unmanufactured asbestos imported into the United States during the calendar years 1906 to 1910 is shown in the following table:

Value of asbestos imported into the United States, 1906–1910.

Year.	Unmanufactured.	Manufactured.	Total.
1906	$1,010,454	$65,716	$1,076,170
1907	1,104,109	200,371	1,316,379
1908	1,068,322	127,548	1,195,870
1909	993,278	240,381	1,233,659
1910	1,235,171	308,078	1,543,249

ASBESTOS OBJECTS.

Asbestos is unique among minerals in having a distinct fibrous structure, with a high degree of flexibility and tensile strength. Furthermore—and this is one of its most important properties—it is incombustible, and is therefore adapted for use in manufacturing

[1] Dept. of Commerce and Labor, Ann. Rept. on commerce and navigation for 1910, Table No. 3, p. 168.

many things for which organic fiber can not be employed. The increased demand for asbestos fabrics, insulating tapes, and more especially for friction facing in automobile brakes, and for steam packings of all descriptions has been most remarkable. For such things, as well as for leggings and shoe coverings among workers of molten metal, only the higher grades of asbestos can be used.

If fine asbestos tapestries were used in this country and the art of spinning asbestos should advance as it has in Europe, many new uses could be found for high-grade asbestos fiber.

The higher grades of asbestos are used largely for steam packing, and it is said are replacing rubber for that purpose. A still larger amount of middle grades is used for steam boiler and pipe covering. According to C. L. Norton, "As ordinarily applied these coverings are about an inch thick, but the best covering of that thickness will not save more than 85 per cent and the poorest ones may be counted upon to save at least 60 per cent of the heat which would be lost from the uncovered pipes."[1]

The use of low grades of asbestos for making shingles, slates, and boards or lumber for general building purposes has greatly increased and the demand for the material is so great that prices of low-grade asbestos have advanced, notwithstanding the decline in prices of the higher and middle grades.

ASBESTOS DEPOSITS OF THE UNITED STATES.[2]

VERMONT.

Asbestos deposits occur at four localities near Lowell, in northern Vermont, connected with the serpentine belt that contains the great asbestos mines of Canada. The topography of these localities has been outlined and described by V. F. Marsters,[3] and their economic value has lately been fully considered by C. H. Richardson,[4] of the Geological Survey of Vermont, in a report on a survey made under the direction of G. H. Perkins, State geologist.

The locality first described by Prof. Richardson is 2 miles northeast of Lowell; the second is northwest of Lowell, in the vicinity of Westfield; and the third and fourth localities are southwest of Lowell, near Mount Belvidere, one at the old mill of the New England Asbestos Co. and the other, by far the most important, at Chrysotile, the old Tucker property, where W. G. Gallager, president of the Lowell Lumber & Asbestos Co., has for the last two years had a mine and mill in successful operation. The chrysotile asbestos produced compares favorably with that of the Canadian mines, and there is a large mass of easily available milling rock at the mine. The output of the mine was increased 24 per cent in 1910, and Mr. Gallager states that the plant is now being so enlarged as to produce 100 tons of fiber daily.

In this connection it is interesting to note a description,[5] by Dr. Fritz Cirkel, the most prominent living authority on asbestos, of the mine of the Lowell Lumber & Asbestos Co. Dr. Cirkel says:

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[1] Letter of Mar. 8, 1911.

[2] The important localities in the United States are much more fully considered in Bull. U. S. Geol. Survey No. 470, 1911. (In press.)

[3] Bull. Geol. Soc. America, vol. 16, 1905, pp. 419–446; also Fourth Ann. Rept. State Geologist Vermont, 1903–4, pp. 86–102.

[4] Seventh Ann. Rept. Vermont Geol. Survey, pp. 315–330.

[5] Cirkel, Fritz, Chrysotile asbestos, its occurrence, exploitation, milling, and uses: Mines branch, Canadian Department of Mines, Ottawa, 1910, 2d edition, p. 219.

The productive belt is about 300 feet wide. The serpentine is of greenish, mottled color, and in its outward appearance is entirely different from that of Black Lake and Thetford. It carries asbestos veins up to 1 inch thick; but the fiber, as a rule, is divided in the middle, parallel to the walls, by a seamy parting of serpentine, sometimes containing fine grains of magnetite and chrome iron ore. At the time of the writer's visit, in March, 1910, the main working pit, which represents an open cut, was 75 feet wide, with a rock face of 40 feet. These veins ramify through the rock in irregular fashion and some rich rock is occasionally met with. About one-half of the serpentine goes to the dump and the balance is a milling material of good quality. No "crude" is obtained. The mill is capable of treating about 200 tons per day, and the fiber produced compares favorably with that found in Canadian mines.

WYOMING.

Two localities near Casper, Wyo., have for some years past attracted considerable attention, one on Casper Mountain, 8 miles directly south of Casper, and the other on Smith Creek, 20 miles southeast of Casper. The asbestos is mainly chrysotile and occurs in serpentine which, like that of Canada and Vermont, is derived by alteration from an intrusive rock, peridotite, rich in olivine.

A mill for fiberizing asbestos was completed by the International Asbestos Mills & Power Co. on Smith Creek in July, 1910, on the property of the Wyoming Consolidated Asbestos Co., and production was begun. A grinding plant is said to have been established at Denver, Colo., and the erection of a mill was commenced in 1910 on the property of the North American Asbestos Co. on Casper Mountain by the Northwestern Mills & Power Co., but the installation of the machinery was not completed until about May, 1911, when C. H. Parker, formerly of the Thetford mines, Canada, became general manager of the properties of both the International and the Northwestern Cos.

In consideration of the quantity and quality of the fiber, of its relations to the markets of the West, and of the mining and milling improvements already installed, the asbestos of the Casper region seems destined to become a factor in the asbestos industry of the United States, but how important a factor it may become and when can not now be told. Much depends upon those who control the claims.

GEORGIA.

The only point at which asbestos is mined in Georgia is in the neighborhood of Sall Mountain. It is of the amphibole variety, or, more specifically, it is anthophyllite. The Sall Mountain Asbestos Co. operates the mine and mill. The whole rock mass that is mined is fibrous and 90 per cent of that removed from the quarry is saved as fiber. The fiber is short and brittle and is of only one grade. About half a dozen masses of the fibrous amphibolite have been opened in the neighborhood of Sall Mountain, but the one farthest southwest, near Cleveland, was worked most during the year 1910, and the output of the company was more than 18 per cent larger in 1910 than in 1909. The mill is about 3 miles from the mine and 12 miles from Clarksville, the shipping point on the railroad.

IDAHO.

The small production of Idaho came from quarries 12 miles southeast of Kamai, the railroad shipping point. The Spokane Asbestos Fire Brick Co. was the only producer, and the material was all used for pipe and boiler covering and wall plaster. Now that the mater has been approved by the trade an increased demand has be reported, and the manufacturing plant in Spokane is to be enlarg to supply the demand. The asbestos is of the amphibole varie of mass fiber like that of Sall Mountain, Ga., and all the rock quarri is available for milling. Although this asbestos is of lower gra and cheaper than chrysotile, its abundance and its occurrence mass fiber are greatly to its advantage in quarrying, transportatic and milling.

ARIZONA.

Some development work has been done in the Grand Canyon and test shipment of a carload, crude, of about 1,500 pounds of asbestos w sent to E. B. Pike, 151 Chambers Street, New York City. Tl result of the tests have not yet been made public.

FOREIGN PRODUCTION AND CONDITIONS.

CANADA.

One of the most notable features in the asbestos industry of Canac for 1910 was a greatly increased production during the first seve months. This stimulation of trade is regarded as a consequence the combination of a number of mines at Thetford and Black Lake t form the Amalgamated Asbestos Corporation (capitalizatio $25,000,000) and the Black Lake Consolidated Co. (capitalizatio $5,000,000). The combinations promised greater economy and eff ciency of administration with wider publicity and extended utilit to increase demand. However, as the demand did not increase a rapidly as the output there was an overproduction and prices declined A great many of the mines have had to shut down altogether[1] and al of the others have curtailed their production, but judging from th history of the industry it is believed that a steady development wil soon follow.

Canada is by far the largest producer of asbestos in the world yielding, if that held in storage is counted, about 78 per cent of the total output in 1910. Its production is of especial interest to the United States, as most of the asbestos mined in Canada is exportec to the States and forms the basis of a large asbestos manufacturing industry. Furthermore, a number of the most important asbestos mines in Canada are owned or controlled by American capital.

[1] Denis, Theodore, Supt. Mines for Quebec, Canadian Min. Jour., Jan. 11, 1911, p. 9.

Production of asbestos and asbestic in Canada for the calendar years 1895–1910, 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
1910	75,678	2,458,929	24,707	17,629

[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 1909 and 1910 were obtained from the preliminary report in 1910 on the mineral production of Canada during the calendar year 1910, pp. 7, 20.

Detail of Canadian production, shipment, stock on hand, and values for 1910.[a]

	Production.	Shipments.			Stock on hand Dec. 31.	
	Tons.	Tons.	Value.	Per ton.	Tons.	Value.
Crude No. 1	1,971	1,688	$445,130	$263.70	1,605	$426,782
Crude No. 2	2,844	1,732	171,684	99.12	2,842	405,419
Mill stock No. 1	16,026	12,830	701,681	54.69	69,933	718,765
Mill stock No. 2	56,321	42,612	997,987	23.42	24,541	591,752
Mill stock No. 3	19,006	16,816	142,447	8.47	3,389	29,988
Total asbestos	96,168	75,678	2,458,929	32.49	39,310	2,172,706
Asbestic	....	24,707	17,629	.71	....	....

[a] McLeisch, John, Preliminary report of the mineral production of Canada during the calendar year 1910, p. 15.

In the absence of a uniform classification of asbestos of different grades, the subdivisions adopted have been based on value, crude No. 1 comprising material valued at $200 or more and crude No. 2 under $200. Mill stock No. 1 includes stock valued at from $45 to $100; No. 2, from $20 to $40; No. 3, under $20.

There were 15 mines producing asbestos in Canada during 1909, and all were in operation at the close of the summer.[1]

[1] Dresser, J. A., Summary report on the serpentine belt of southern Quebec for the calendar year ending Dec. 31, 1909.

RUSSIA.

Russia ranks next to Canada in the production of asbestos and i becoming an important competitor in the world's supply. The Ru sian field was briefly described in Mineral Resources for 1908. that year the production of Russia amounted to 10,802 short ton in 1909 it increased to 14,654 tons. One or more mills have bee erected and asbestos goods are now manufactured. Complete r turns are not available for 1910, but four of the mines northeast Ekaterinburg are reported[1] as producing 11,450 tons. The tot production for the year must be larger, for a number of active min are not included in these returns. If the rate of increased produ tion in 1909 continued through 1910, the total production for Russi for 1910 would be 19,783 tons.

According to the latest report of the consul-general, John H. Snod grass, of Moscow, March 28, 1911, the asbestos output of the Ural in 1910 was 12,203 short tons, a decline of 2,451 short tons as com pared with the preceding year. Twenty-one mines are now bein operated in the Urals. There was a comparatively insignifican production in other provinces. The exports of asbestos from Russi for the last three years have been as follows:

Exports of asbestos from Russia 1908–1910, in short tons.

	Quantity.	Value.
1908	8,154	$586,07
1909	9,144	630,36
1910	8,856	805,97

The increased valuation especially in 1910 suggests the export of better grades.

The active mines cover a distance of 20 miles north of Ekaterinburg, but prospects extend 200 miles southwestward from that region to Orenburg. The whole district is in Perm, in the Ural Mountains.

Part of the Russian production is obtained from the southern border of Siberia, on the Yenisei, near Minisinsk, where a French company is operating. Many promising prospects are reported from the Altai Mountains and the region to the south, but no definite knowledge is available concerning them.

SOUTH AFRICA.

All the asbestos mined in South Africa thus far has been of the higher grades. In this region there are no mills, and the difficulties of transportation retard development, but a comparison of the amount of crude asbestos produced with that produced in Canada suggests interesting possibilities. The output comes from Cape Colony, the Transvaal, and South Rhodesia. The total production in 1910 probably exceeded 2,000 tons, but definite figures are not available except for Rhodesia, which produced approximately 200 tons in the last six months.

[1] Min. Jour. (London), Feb. 4, 1911, p. 123.

Portuguese East Africa produced in 1908 about 1,600 tons of asbestos, which had an average value of more than $173 pe· ton. This grade was somewhat higher than that of British South Africa.

ITALY.

Italy has for years regularly produced a superior quality of asbestos, but at no time has her production been large. According to Merrill [1] the Italian asbestos that comes to this country is of the amphibole and serpentine varieties, both being remarkable for the beautiful long fibers they yield. The amphibole is from Mont Cenis and the serpentine from Aosta.

CYPRUS.

Within the last few years an asbestos mine has been opened on Mount Troodos in eruptive rocks [2] similar to those of the Canadian mines. A royalty of 10 per cent is paid to the Government. Up to the spring of 1909 the mining methods employed were primitive and less than 500 tons of asbestos had been exported, but recently a plant having a capacity of 3,000 tons of asbestos annually is said to have been installed, and the locality appears to promise a considerable production.

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[1] Merrill, G. P., The nonmetallic minerals, 1910, p. 193.
[2] Zdarsky, in Zeitschr. prakt. Geologie, September, 1910.

ASPHALT.

By David T. Day.

PRODUCTION.

It is the practice to include under the term "asphalt" the solid varieties used in asphalt varnish, the mixture of sand or limestone with asphalt called bituminous rock, and the semisolid residue left after distilling off the lighter constituents of asphaltic varieties of petroleum.

In the combined production of these varieties there was an increase in the total output from 228,655 tons, valued at $2,138,273, in 1909 to 260,080 tons, valued at $3,080,067, in 1910, but the trade conditions affecting the production of the different classes of asphalt are so dissimilar that one class may be affected very favorably during a given period, while another class may be depressed by the same general trade conditions.

The year 1910 was rather remarkable for the impetus given to the building of better roads. The experimental work carried on by various municipal, State, and national highway bureaus has generally favored the use of semiliquid asphalt as a binder, and this has stimulated the demand for the asphalt obtained as a residue from the Texas, California, and other oils. This product increased from a total of 128,861 short tons in 1909 to 159,424 short tons in 1910, and the value at the place of production increased from $1,558,463 in 1909 to $2,207,937 in 1910. This represents an increase in price from $12 per short ton in 1909 to nearly $14 in 1910, which shows that the greater production did not serve to demoralize prices but was a legitimate response to an increased consumptive demand. An interesting bulletin on the use of bitumens in road building has recently been published by the Office of Public Roads of the United States Department of Agriculture.[1]

Bituminous rock, which also contributed to the development of better roads, also showed a noteworthy increase in production, while the total contributions of asphalt to the varnish trade showed a decline.

The total production of all kinds of asphalt since 1882 is shown in the table following:

[1] Bitumens and their essential constituents for road construction and maintenance: Circ. Off. Pub. Roads No. 93, U. S. Dept. Agr., 1911.

Production of asphalt and bituminous rock, 1882–1910, in short tons.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
1882	3,000	$10,500	1897	75,945	$664,[illegible]
1883	3,000	10,500	1898	76,337	675,[illegible]
1884	3,000	10,500	1899	75,085	553,[illegible]
1885	3,000	10,500	1900	54,389	415,[illegible]
1886	3,500	14,000	1901	63,134	555,[illegible]
1887	4,000	16,000	1902	105,458	765,[illegible]
1888	50,450	187,500	1903	101,255	1,005,4[illegible]
1889	51,735	171,537	1904	108,572	879,[illegible]
1890	40,841	190,416	1905	115,267	758,1[illegible]
1891	45,054	242,264	1906	138,059	1,290,3[illegible]
1892	87,680	445,375	1907	223,861	2,826,4[illegible]
1893	47,779	372,232	1908	198,382	2,057,8[illegible]
1894	60,570	353,400	1909	228,655	2,138,2[illegible]
1895	68,163	348,281	1910	260,080	3,080,0[illegible]
1896	80,503	577,563			

The changes in production in the different classes of asphalt ar
detailed for several years in the table which follows:

Production of asphalt, 1907–1910, by varieties, in short tons.

Variety.	1907		1908		1909		1910	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Bituminous rock	45,526	$129,040	37,371	$146,821	55,376	$205,756	64,554	$400,55[illegible]
Refined bitumen	1,744	16,568	4,536	48,780	733	6,964	1,763	17,89[illegible]
Gum	5,195	78,400	7,000	88,000	10,220	105,220	3,255	68,03[illegible]
Maltha	13,507	143,758	12,875	162,000	652	8,047	1,252	12,74[illegible]
Wurtzilite (elaterite)	422	35,327	450	36,000	220	1,400	....	....
Gilsonite	20,285	531,965	18,533	61,824	28,669	218,186	29,832	372,90[illegible]
Grahamite	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	136,204	1,881,540	115,281	1,491,616	128,861	1,558,463	159,424	2,207,937
Total	223,861	2,826,489	198,382	2,057,881	228,655	2,138,273	260,080	3,080,067

The table following shows the production of asphalt, by States
and kinds, in 1909 and 1910.

Production of asphalt in 1909 and 1910, by varieties and by States, in short tons.

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

1910.

Variety.	California.		Utah.		Oklahoma.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Bituminous rock	37,547	$128,212	5,110	$153,398	11,959	$65,244
Mastic	476	5,670				
Refined bitumen	2,500	25,000	755	43,035		
Maltha	1,252	12,742				
Uintaite (gilsonite)			29,832	372,900		
Wurtzilite (elaterite) and tabbyite						
Grahamite						
Oil asphalt	101,711	1,167,112				
Total	143,486	1,338,736	35,697	569,333	11,959	65,244

Variety.	Kentucky.		Texas.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Bituminous rock	9,938	$53,703			64,554	$400,557
Mastic	1,287	12,226			1,763	17,896
Refined bitumen					3,255	68,035
Maltha					1,252	12,742
Uintaite (glisonite)					29,832	372,900
Wurtzilite (elaterite) and tabbyite						
Grahamite						
Oil asphalt			57,713	$1,040,825	159,424	2,207,937
Total	11,225	65,929	57,713	1,040,825	260,080	3,080,067

a Includes small output from West Virginia.

CHARACTERISTICS OF SOLID BITUMENS.

The following table shows the chief characteristics of the principal varieties of solid bitumens:

Chief characteristics of the principal varieties of solid bitumens.

Name.	Common name.	Specific gravity.	Color.	Fusibility.	Solubility.					Composition.			
					In gasoline (of 76° Baumé).	In ether.	In carbon bisulphide.	In carbon tetrachloride.	In turpentine.	Sulphur.	Oxygen.	Carbon.	Hydrogen.
										P. ct.	*P. ct.*	*P. ct.*	*P. ct.*
Uintahite...	Gilsonite..	1.068 to 0.170	Brilliant black powder. Streak lighter brown, than albertite.	Easily fusible in candle flame; burns and acts like scaling wax, leaving sharp impression.	Soluble in petroleum ether.	Slowly; not wholly soluble as powder.	Entirely soluble.	Almost entirely soluble.	Freely soluble in hot turpentine; less soluble in cold turpentine.	1.55	......	88.79	9.31
Wurtzilite..	Elaterite.. Tabbyite. Aeonite. Aegerite.	1.0227	Jet black by reflected light; deep red in thin plates	Nonfusible in hot water, but softens, toughens, and becomes more elastic. In candle flame softens and melts and burns with bright flame.	Practically insoluble.	About 4 per cent soluble.	Partly soluble.	Slightly soluble.	Fairly soluble.	5.83	......	80.00	12.23
Wiedgerite[a]	Mineral Liver.	1.02	Liver brown....	Soft; not as elastic as rubber.	Soluble....	Soluble.....	Soluble.....	Soluble.....	Soluble.....	......	......	......	......
Grahamite .	Grahamite	1.145	Black, but powder and streak chocolate brown.	Melts imperfectly with decomposition of surface; in this state the interior may be drawn into threads.	Partly soluble.	Partly soluble.	Readily soluble.	....	Swells and nearly all dissolves.	Tr.	13.46	76.45	7.83
Impsonite[b].	....	1.175	Jet black........	Does not soften in boiling water.	Insoluble...	5 per cent soluble.	Completely soluble.	Partly soluble.	Almost insoluble.	1.47	2.00	86.57	7.26
Albertite...	Albertite..	1.08 to 1.11	Black; streak black: powder black to dark brown.	In spirit flame intumesces and emits gas, but does not melt; melts in closed tube.	....	About 4 per cent soluble.	Partly soluble.	Partly soluble.	30 per cent soluble.	Tr.	1.97	86.04	8.96
Oil asphalt.	....	.9825	Brownish black.	....	90 per cent soluble.	90 per cent soluble.	99.9 per cent soluble.	99.9 per cent soluble.	99.9 per cent soluble.	0.30	......	84.1	15.2

Refined bitumens.	A	1.008	Black	....	Melts in hot water	80 per cent soluble.	80 per cent soluble.	99.9 per cent soluble	99.5 per cent soluble.	99.5 per cent soluble.	.35	....	84.7	14.7
	B	1.023	....do	....	Softens in hot water; does not melt.	75 per cent soluble.	76 per cent soluble.	99.8 per cent soluble.	99.2 per cent soluble.	99.5 per cent soluble.	.40	....	85.1	14.3
	C	1.039	....do	....	Softens in hot water; melts in candle flame; tough and pliable at ordinary temperatures; brittle in very cold weather.	70 per cent soluble.	73 per cent soluble.	99.7 per cent soluble.	99.0 per cent soluble.	99.5 per cent soluble.	.43	....	85.5	13.9
Ozokerite c			.85-.95	....	Fuses at 56° to 70° F.	Soluble	Some varieties wholly soluble.	Soluble	Soluble	Soluble	Tr.	Tr.	85.25	15.09

a An impure soft mass, containing much sulphur and water. Turns black on exposure. Has not yet been carefully described.
b See description by J. A. Taff, Bull. U. S. Geol. Survey, No. 380, pp. 286-297.
c Blackf rom contained asphalt.

IMPORTS.

The following table shows the imports of asphalt by calendar years from 1906 to 1910, inclusive:

Asphalt imported for consumption into the United States, 1906–1910, in short tons.

Year.	Crude.		Dried or advanced.		Bituminous limestone.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
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
1910	162,435	588,206	20,180	178,704	3,696	9,301	186,311	a 785,963

a Imports for 1907 include $3,100 of manufactures; 1908, $4,560; 1909, $8,988; 1910, $9,752.

EXPORTS.

During the fiscal year ending June 30, 1910, domestic unmanufactured asphalt and manufactures of asphalt to the value of $702,520 were exported from the United States, as against similar exports valued at $425,429 in 1909 and $451,968 in 1908.

EXPORTS FROM TRINIDAD.

The exports of asphalt from Trinidad from 1906 to 1910, inclusive, are shown in the following table:

Total exports of asphalt from Trinidad, 1906–1910, in short tons.

Year. a	To United States.			To Europe.			To other countries.			Grand total.
	Lake.	Land.	Total.	Lake.	Land.	Total.	Lake.	Land.	Total.	
1906	71,902	5,292	77,194	68,284	454	68,738				145,932
1907	97,243	4,642	101,885	59,987	224	60,211		230	230	162,096
1908	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
1910	109,198	9,274	118,472	65,778	150	65,928				184,400

a Ending Jan. 31 of year succeeding.

UNITED STATES GEOLOGICAL SURVEY PUBLICATIONS ON ASPHALT.

The following list comprises the more important papers relative to asphalt published 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.

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FULLER'S EARTH.

By Jefferson Middleton.

INTRODUCTION.

The fuller's earth resources of the United States have attracted considerable attention for several years because of the increasing demand for this material for use as a clarifying agent for mineral and vegetable oils. The original use from which it derives its name, the fulling of cloth, is now a minor one.

Chemically it is a clay, high in combined water; in color it ranges from gray to dark green; when dry it often adheres to the tongue, though this quality is found in some other clays. A chemical analysis is of little value in determining the value of clay as fuller's earth; the actual use is the only criterion.

OCCURRENCE.

Fuller's earth occurs in Alabama, Arkansas, California, Colorado, Florida, Georgia, Massachusetts, Nebraska, New York, South Carolina, South Dakota, Texas, Utah, and Virginia, though it was produced in 1910 in but eight States, the six reporting no production being Alabama, Nebraska, New York, South Dakota, Utah, and Virginia.

MINING AND PREPARATION.

In this country, fuller's earth is mined with pick and shovel. When mined it contains more or less water and is dried either in the sun or by artificial means. After being dried it is ground to 60 mesh or finer and is then ready for shipment. In England the earth is washed in long, narrow troughs very much like hydraulic sluice boxes, a large percentage of the material being allowed to settle out as sand, while the lighter material goes off into settling tanks, where it is dried; it is then sold in the resulting lump form.

USES.

As already mentioned, the principal use of fuller's earth in this country is the bleaching, clarifying, or filtering of fats, greases, and oils. The common practice with mineral oils is to dry the earth carefully, after it has been ground to 60 mesh or finer, and run it into long cylinders, through which the crude black mineral oils are allowed to percolate very slowly. As a result, the oil that first comes out is perfectly water white and much thinner than that which follows. The oil is allowed to continue percolating through the earth until the color reaches a certain maximum shade.

With the vegetable oils, the process is radically different. The oil is heated beyond the boiling point of water in large tanks; from 5 to 10 per cent of its weight of fuller's earth is then added, and the mixture is vigorously stirred and then filtered off through bag filters.

The coloring matter remains with the earth, the filtered oil being of a very pale straw color, provided the operation has been conducted with sufficient care.

HISTORY.

For a great many years fuller's earth, as its name indicates, was used for fulling cloth, and until 1893 it was imported for this purpose from England, the then only known source of supply. With the growth of the domestic vegetable-oil industry a demand arose for a clarifying agent and fuller's earth was used extensively, whereas for filtering mineral oils bone black was used. Upon the discovery of fuller's earth in this country it superseded bone black as a detergent for mineral oils. From the first it was found that the American earths were better adapted for use on mineral oils, and the English earths were better for fats and vegetable oils. In clarifying vegetable and animal fats with American earths a more or less disagreeable taste is left. Just why this is has never been determined.

The discovery of fuller's earth in this country in 1893 was by accident. At Quincy, Fla., an effort which proved a failure was made to burn brick on the property of the Owl Cigar Co. An Alsatian cigar maker employed by the company called attention to the close resemblance of this clay to the German fuller's earth. As a result of this suggestion, the clay was tested and was found to be fuller's earth, and the industry was developed. In consequence of this discovery there was considerable excitement, and supposed deposits of fuller's earth were reported from a number of States. As usual, the material in the most of these deposits was found to be of no value as fuller's earth.

Since the discovery of fuller's earth in 1893, Florida has been the leading producing State. During the early history of the industry the production was from only two or three States. In 1897–1899 it was reported from Florida, Colorado, and New York, with a very small production from Utah; in 1901 Arkansas was added to the list. From 1904 to 1907 Arkansas was the second largest producer. Fuller's earth was found in Georgia soon after its discovery in Florida, but Georgia did not appear as a producer until 1907, when it was the third largest producing State; it ranked second in 1909 and 1910. In 1904 Alabama and Massachusetts reported production, in 1907 South Carolina and Texas first appeared, and in 1909 California entered the list.

PRODUCTION.

The following table shows the production of fuller's earth in the United States from the inception of the industry:

Production of fuller's earth in the United States, 1895–1910, in short tons.

Year.	Quantity.	Value.	Average price per ton.	Year.	Quantity.	Value.	Average price per ton.
1895	6,900	$41,400	$6.00	1903	20,693	$190,277	$9.20
1896	9,872	59,360	6.01	1904	29,480	168,500	5.72
1897	17,113	112,272	6.56	1905	25,178	214,497	8.52
1898	14,860	106,500	7.17	1906	32,040	265,400	8.28
1899	12,381	79,644	6.43	1907	32,851	291,773	8.88
1900	9,698	67,535	6.96	1908	29,714	278,367	9.37
1901	14,112	96,835	6.86	1909	33,486	301,604	9.01
1902	11,492	98,144	8.54	1910	32,822	293,709	8.95

This table shows that in 1910 the production decreased 664 short tons, a loss of 1.98 per cent in quantity and of $7,895, or 2.62 per cent, in value. The maximum output and value were in 1909, being 33,486 tons, valued at $301,604. The highest average price per ton was $9.37 in 1908 and the lowest was $5.72 in 1904.

The following table shows the production of fuller's earth in 1910, by States:

Production of fuller's earth in the United States in 1910, by States, in short tons.

State.	Number of operating producers reporting.	Quantity.	Value.	Average price per ton.
Arkansas	4	2,563	$29,137	$11.37
California and Colorado	3	568	8,085	....
Florida	3	18,832	170,267	9.04
Georgia, Massachusetts, and South Carolina	4	9,995	77,638	....
Texas	3	864	8,582	9.93
Total	17	32,822	293,709	8.95

This table shows that Florida was the leading producing State in 1910, and reported 57.38 per cent of the quantity, and 57.97 per cent of the value of the total production. The other States in the order of their rank in output and value in 1910 were as follows: Georgia, Arkansas, Texas, California, Massachusetts, South Carolina, and Colorado. The average price per ton in the States combined in the table was as follows: California, $15.79; Colorado, $9.93; Georgia, $7.79; Massachusetts, $7.14; South Carolina, $8.00.

IMPORTS.

The following table shows the imports of fuller's earth from 1897 to 1910, inclusive:

Fuller's earth imported for consumption into the United States, 1897 to 1910, in short tons.

Year.	Unwrought or unmanufactured.			Wrought or manufactured.			Total.	
	Quantity.	Value.	Average price per ton.	Quantity.	Value.	Average price per ton.	Quantity.	Value.
1897[a]	2,585	$14,283	$5.53	2,395	$20,037	$8.37	4,980	$34,320
1898	2,283	15,921	6.97	7,073	55,123	7.79	9,356	71,044
1899	4,192	23,194	5.53	7,366	46,446	6.31	11,558	69,640
1900	2,723	14,750	5.42	6,431	50,047	7.78	9,154	64,797
1901	3,266	17,230	5.28	8,792	63,467	7.22	12,058	80,697
1902	4,239	26,635	6.28	10,895	75,945	6.97	15,134	102,580
1903	4,260	28,339	6.65	12,840	92,332	7.19	17,100	120,671
1904	1,975	9,546	4.83	8,247	64,460	7.82	10,222	74,006
1905	1,705	12,798	7.51	12,858	93,199	7.25	14,563	105,997
1906	2,905	20,129	6.93	11,920	88,566	7.43	14,825	108,695
1907	2,490	16,833	6.76	13,916	105,388	7.57	16,406	122,221
1908	2,363	16,242	6.87	9,803	77,171	7.87	12,166	93,413
1909	1,802	12,492	6.93	10,950	88,659	8.10	12,752	101,151
1910	2,160	14,399	6.67	14,427	118,146	8.19	16,857	132,545

[a] July to December.

In the following table is shown the quantity and value of t fuller's earth imported from 1867 to 1883, by fiscal years. T wrought and the unwrought earths were not classified separate during this period. From July 1, 1883, to June 30, 1897, fulle earth was not reported separately in the customhouse returns the Treasury Department, but was included under minerals "n elsewhere specified."

Imports of fuller's earth into the United States, 1867–1883, in short tons.

Year ending June 30—	Quantity.	Value.	Year ending June 30—	Quantity.	Valu
1867	314	$3,113	1876	277	$3,[illegible]
1868	236	2,522	1877	448	4,[illegible]
1869	363	3,587	1878	375	4,[illegible]
1870	268	2,619	1879	404	4,[illegible]
1871	325	3,383	1880	647	6,[illegible]
1872	307	3,358	1881	300	3,[illegible]
1873	281	2,978	1882	1,017	11,[illegible]
1874	310	3,440	1883	1,390	14,[illegible]
1875	336	3,694			

FULLER'S EARTH IN TEXAS.

Bulletin 470 [in press], Contributions to Economic Geology, 191(Part 1, contains "Notes on some clays from Texas," by Alexande Deussen, who describes eight deposits of fuller's earth. Tests t determine the value of these clays as fuller's earth are in progress but at this time (May, 1911) the results are not available. The fol lowing is an abstract of the portion of the paper relating to fuller' earth:

Somerville Fuller's Earth Co.'s plant.—This plant and pit ar located 3 miles north of Somerville, Burleson County, 1 mile west o the Gulf, Colorado & Santa Fe Railway. In the pit is exposed 1 feet of brown fuller's earth, which dips beneath hard, gray sand stones about 200 feet from this point. The deposit is about 50 acre in extent. Over most of this area the clay is covered with over burden varying in thickness from 3 to 10 feet and consisting in some places of soil and gravel and in others of soil and gravel and sand stone.

The fuller's earth is a fine-textured, compact, even-grained, hard brown clay. Joint and fracture planes are numerous, and along these planes and the lamination planes there is a slight coating of limonite, which has been deposited by water. Occasional nodules of pyrite, averaging three-fourths of an inch in diameter, are also present.

Lignite from Milano and Rockdale and cordwood from the vicinity of the deposit are available for fuel. Good water can be had from wells less than 500 feet deep, and natural drainage keeps the pit free from water.

This deposit was worked for a short time in 1909 and 1910, but the enterprise did not prove a success. The earth was dried and ground to 80 to 200 mesh. The fineness of the material is ascribed as one of the causes for the failure of the enterprise; and the long haul by wagon as another. The clay was dug with pick and shovel.

Texas Fuller's Earth Co.'s plant.—The plant of this company is located 7 miles north of Burton, the nearest shipping point, on the David Heirs League, in Washington County. A small quantity of fuller's earth was shipped from this plant in 1909, but the business was not successful. The deposit consists of soft brown fuller's earth and covers about 250 acres. There are two strata here, one 4 feet thick, 10 feet from the surface, and another 5 feet thick separated from the first by 6 inches of lignitic shale. The first-mentioned stratum is the one that has been worked. The average thickness of the overburden is 6 feet.

The distance from the railroad, 7 miles, was one of the principal causes of the failure of the business; another reason being the cost of working under a 6-foot overburden.

Melcher's fuller's earth.—Five miles south of West Point, on lot No. 34, W. F. Hamilton League, in Fayette County, on the property of J. C. Melcher, of O'Quinn, occurs a deposit of fuller's earth, varying in thickness from 6 to 16 feet, covered with an overburden from 2 to 10 feet in thickness. This earth is exposed in the banks of a small hollow, showing a section 16 feet thick, very uniform in physical and chemical composition. At this point it is overlain by 2 feet of gravel that could be utilized for ballast. This point seems favorable for the location of a plant on account of the facilities for shipment—the railroad being but half a mile distant—the little overburden, the thickness of the bed, the natural drainage facilities, and abundant fuel.

The earth is light brown of very fine texture. A thin film or coating of limonite pervades the joint and lamination planes.

Clay on the Murray farm.—On the farm of J. C. Murray, 3 miles north of Lyons, in Burleson County, occurs a hard blue shale that may tentatively be classed as fuller's earth. It consists of a compact blue shale of uniform chemical and physical composition 5 feet thick. A number of shafts have been sunk which show that the deposit covers about 40 acres, but the material is probably available under from 70 to 80 acres. The overburden is from 2 to 10 feet thick. The main line of the Gulf, Colorado & Santa Fe Railway crosses this farm, so that shipping facilities would be good.

Tests showed that this clay is unsuitable for the manufacture of clay products.

Clay on the Paul Taylor farm.—On the farm of Paul Taylor, 1½ miles northwest of Somerville, in Burleson County, occurs an extensive deposit of compact, brown, leaf-bearing shale that may be tentatively classed as fuller's earth. This deposit lies directly on top of the gray sandstones described as overlying the clay at the Somerville Fuller's Earth Co.'s plant. It is here exposed on a branch of Yegua Creek, and shows a thickness of 13.2 feet with an overburden 6.8 feet thick. It is a compact, fine-grained, even-textured clay of uniform chemical and physical composition over a large area. It is situated 500 yards west of the main line of the Gulf, Colorado & Santa Fe Railway and could easily be reached by a spur. Natural drainage is good for any pits that might be opened. Tests made by Frank Graves, of Burton, are said to have shown that the earth possesses high bleaching and decolorizing power.

Tests showed that it is not suitable for the manufacture of clay products.

Clay on Red Gully.—On Red Gully Creek, 4 miles north of Burto in Washington County, occurs a deposit of hard, brown, leaf-beari shale owned by William Bauer, of Burton. It is exposed in the ca yon walls of Red Gully Creek, the section showing 10 feet of the sha and $6\frac{1}{2}$ feet of overburden consisting of sandstone, lignitic clay, an shale. It is a compact fine-grained clay, of uniform chemical an physical composition, but exceedingly hard. This deposit has be prospected by Mr. Graves, of Burton. He put down several dr holes which showed that there is a considerable body of clay rangi from 5 to 10 feet in thickness and covered with an overburden fro 5 to 10 feet thick.

The deposit is located $7\frac{1}{2}$ miles from Burton, the nearest railro point, a distance which for the present, at least, makes this cla unavailable.

Tests of the bleaching power of this clay made by Mr. Graves a said to have shown good results. Tests made by the Survey sho that it is well adapted to the manufacture of building brick.

Clay near Ledbetter.—On a branch of Turkey Creek, about 2 mil east of Ledbetter, in Washington County, on the Burkhart lan occurs a deposit of brown shale or fuller's earth that is similar in ge eral character and geologic relations to the clay of the Somervil Fuller's Earth Co. It is a soft, compact, even grained, light brow shale or fuller's earth of uniform physical and mineralogical compos tion. Little can be said concerning the extent of this deposit, but i probably covers an extensive area, for it was encountered in puttin down a shaft at the lignite mines, 2 miles west of the point of exposure The overburden varies from 2 to 5 feet and consists chiefly of grave and clay. This gravel may, as indicated in connection with th description of other deposits, be used as railroad ballast. The grave flat is covered with a heavy growth of post-oak timber, which con stitutes an available source of fuel for this clay and in addition, a considerable body of lignite occurs beneath this clay. The deposit i only a mile from the railroad and could easily be reached by a spur

Tests show that this clay is not suitable for the manufacture o clay products.

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GEMS AND PRECIOUS STONES.

By Douglas B. Sterrett.

INTRODUCTION.

There was a decrease in the production of precious stones in the United States during 1910, though the output of such matrix gems as turquoise and variscite was still large. Nearly 8½ tons of rough turquoise were produced in 1910, as compared with more than 17 tons in 1909, and more than 2½ tons of rough variscite, as compared with 3½ tons in the preceding year. New deposits of both these minerals were found in Nevada and a very promising deposit of variscite was developed near Lucin, Utah. New deposits of californite were discovered in California, and a white garnet scarcely to be distinguished from the white vesuvianite variety of californite was found in quantity in Siskiyou County, Cal. This mineral is with difficulty distinguished from white jade, for which it could well be substituted.

The output of tourmaline was considerably less in 1910 than in 1909, but a new deposit of fine gems and specimens of tourmaline was opened in Maine. The aquamarine deposits on Mount Antero, Colo., yielded a quantity of good gem material along with crystals of associated minerals, as phenacite, colorless and smoky quartz, etc. The development of the new emerald prospect in North Carolina was limited and met with only partial success. More recent work during 1911 has resulted in finds of better promise. The presence of valuable gem material has been proved, but the quantity of gems to be expected from the vein is still a matter of doubt. Further prospecting and dredge mining for the variegated sapphires of Montana were carried on, but the principal value of the sapphire production came, as usual, from the deposits of blue sapphire in Fergus County.

AGATE.

COLORADO.

A large number of agates are sold each year at the summer resorts of Colorado. Many of these agates are imported, having first been polished in Germany, but some are native stones either polished abroad or in the United States. Colorado yields some very pretty agates, and some are being successfully handled in the tourist trade. Mr. J. D. Endicott has obtained considerable agate of good quality from several places in the Canon City region. Among these are Curio Hill and the Garden Park localities.

Curio Hill.—Curio Hill is 6½ miles due south of Canon City, on the Yorkville road. It is a small hogback ridge, at the end of and transverse to a spur on the east side of the West Mountains. The hill is about 400 yards long in a direction west of north and east of south, and rises about 150 feet above the terrace country on the east, or about 6,300 feet above sea level. The locality has been known for many years and has been visited occasionally by curio seekers. No mining for agate has been carried on, but a few blasts have been put in and the soil turned over in places. The agates have been found for a distance of nearly 300 yards along the eastern slope of the hill and in a few places along the top. They are more plentiful near the middle and at the south end of the hill. Curio Hill is composed chiefly of cherty limestone, which weathers to a reddish color on exposure. The limestone is at least 60 feet thick and outcrops as a ledge along the summit of the ridge. A specimen of fossil sponge from this limestone was regarded as of Ordovician age by Dr. G. H. Girty of the United States Geological Survey. On the west of the hill is a mass of red granite of medium grain. Near the highest part of the ridge is a lens of hard, fine, white quartzite. About 175 yards east of the summit of Curio Hill a ledge of buff and red sandstone outcrops forming a small cliff. The strike of the formations on Curio Hill varies from N. 10° W. to N. 35° W. and the dip is about 75° SE. The hogback of Curio Hill is evidently formed by faulting of the limestone and quartzite against the granite. The greater part of the quartzite was cut out by a curved fault, leaving only a short slice between the granite and limestone.

The agates are found loose in the soil along the foot of Curio Hill, in the talus on its slope, and in place in the limestone ledge forming its backbone. The loose specimens have been released by the weathering of the original rock matrix, probably chiefly limestone like that along the summit of the ridge, and have accumulated on the surface with other difficultly soluble constituents of the matrix. The agate occurs in the limestone in irregular augen and ball-shaped geodes, in veins, seams, and partially filled cavities with mammillary and reniform surfaces. Fragmentary pieces are found loose in the soil. Nearly all of the agates have some banding, and some of the geodes show the "fortification" agate structure. The banding varies from coarse to very fine, and in some cases these variations appear in the same specimen. The interior of some of the geodes and cavities is lined with quartz crystals and occasionally calcite is present. The agates range in color from white to light gray, to dark gray, to yellowish red, to brownish red, to cherry red. Combinations of two or more of these colors are generally present in a single specimen. Much of the agate is translucent. The majority of the agates are not large, and specimens of the best quality measuring 2 inches across are not abundant. The delicate markings and intricate patterns exhibited by some of the agates has led to their being called "fancy agates." The natural colors of many of the agates from Curio Hill are sufficiently pretty not to require intensification by burning and other treatment.

Garden Park.—Agate and jasperized bone are found at the dinosaur fossil bed locality, 7 miles due north of Canon City, on the south side of Garden Park. The deposits are in the rough hills on the west side of Oil Creek. The jasperized bone horizon is a few hundred feet above that of the agate. This occurrence was mentioned in this report for 1908 and reference was made to a more widespread occurrence of similar agates as noted by Willis T. Lee.[1] An examination of the dinosaur bed locality places the agate horizon near the base of the Morrison formation,[1] of Jurassic (?) age. The soft shales of the upper part of this formation have yielded many dinosaur fossils for museum collections. The bones of these animals have been petrified by siliceous material, producing red, brown, and yellow jasper, with gray and white matrix, consisting in part of chalcedony. The replacement of different parts of the bone tissue by minerals with different colors has produced a variety of effects. The structure of the bone is shown up well by the spots and mottlings of dark jasper in lighter-colored matrix. Some of the petrified bone polishes well and makes a handsome ornamental stone and some is sufficiently pretty to use in jewelry. Much of the bone has been replaced by minerals of variable hardness and is therefore difficult to polish evenly. Fragments of the bone are scattered over a considerable area, and specimens several inches across are not uncommon.

The fancy agates occur in a loose gray and red to purple clay shale, in which are included occasional beds of sandstone and limestone. Concretions of limestone and seams of calcite also occur in the same formation. The calcite seams have the structure of satin spar and some are delicate pink. The agates occur in the form of geodes, seams, and rough segregations. Some of them have replaced other minerals and organic material. A small gasteropod shell, petrified by carnelian-colored agate, was found at this locality, and was identified as *Valvata leei* by Willis T. Lee, for whom the species was named by W. N. Logan.[2] Such shells would make unique stones for scarf pins if they could be found in greater quantity. The agates from this locality are small. Their bandings, marking, and patterns are very delicate and beautiful, and the colors are varied and bright. Fortification agate is a common variety and yields widely varying effects when cut. The colors vary through white, gray, different shades of yellow, orange, brown, blood red, and cherry red. The different colors are often present in the same specimen and, combined with the extremely delicate bandings and odd patterns of the agate, yield a remarkably pretty gem stone. A beautiful variety is the St. Stephen stone—a translucent chalcedony with round blood-red spots through it. The natural color of the fancy agates from this locality probably could not be improved by artificial treatment, so commonly necessary with agates from other localities.

NEVADA.

Specimens of chalcedony and agate were kindly sent to the Survey by Mr. M. M. Holland, of Coaldale, near which place they were found. The specimens consist of mammillary shells and lumps of highly translucent grayish chalcedony up to an inch in thickness and of greater breadths. The chalcedony is very pure and even textured.

[1] The Morrison shales of southern Colorado and northern New Mexico: Jour. Geology, vol. 10, No. 1, 1902, p. 44.

[2] The stratigraphy and invertebrate faunas of the Jurassic formation in the Freezeout Hills of Wyoming: Kansas Univ. Quart., April, 1900, p. 133.

A dark-greenish coating with a white border is attached to one side of some of the specimens. One specimen shows a white onyx banding.

Mr. Louis Sigmund, of Mina, Nev., reports the discovery of a vein of chalcedony, semiopal, and common opal, about 2 miles southeast of Redlich in a granite formation. Specimens kindly furnished consist of very translucent gray chalcedony and milky-white opal. The vein of chalcedony is said to be from 2 to 6 inches in thickness.

TEXAS.

Prof. Johan A. Udden, of Rock Island, Ill., reports observing agates in the hills directly west of Hancock's ranch, about 18 miles north-northeast of Alpine, Tex. The agates are fairly plentiful and range in size from 1 to 3 inches in diameter. They are marked with concentric bandings.

ARIZONA.

Mr. John L. Riggs, of Chloride, Ariz., states that much chalcedony and opalescent chalcedony is found in Mohave County. This material would cut into stones similar to the chalcedony called moonstone found on the California beaches. Some banded chalcedony or agate is found, also some tinted with blue and pink.

AMBER.

PRUSSIA.

Notes on the amber deposits on the Baltic owned by the Prussian Government have been given by O. H. Hahn.[1] The deposits occur all along the coast of the Baltic from Danzig, West Prussia, to Memel, East Prussia. The most productive region of present times is along the coast from Palmnicken north to Brüserort Lighthouse and then east to Neukuhren. The amber industry is an ancient one, for the mineral was gathered by fishermen in early times. The ownership of the deposits is vested in the State and rights were formerly leased. The industry has proved very profitable to the State. Amber was later obtained by mining methods, and now probably only one-twentieth of the output is obtained by search and by fishing. Mining has been of three kinds—large open-cast pits, underground mining, and dredging. At present the greater part of the amber is obtained by sinking shafts to the productive stratum and then tunneling out on it. It is said that the quicksands overhead are giving much trouble and that it may be necessary to return to open-cast methods. The principal shaft is near Palmnicken, and is said to be about 60 feet deep and to have about 2 miles of drifts from it. The amber-bearing bed is a stratum of bluish-gray sandy clay, locally called "blaue Erde."

The crude amber from the mine is washed in revolving barrels and scoured with rattan brushes to remove clay and impurities. The amber floats to the surface and is skimmed off. After cobbing it is sacked for shipment to Konigsberg, where the State disposes of it after careful sorting. Large pieces of amber are not common. A specimen weighing 15 pounds has been found, and another of 8½ pounds

[1] Eng. and Min. Jour., Apr. 8, 1911.

is now in a museum. The production of crude amber amounts to about 350 metric tons per year. Statistics for one year showed that 712,086 mine cars of "blaue Erde" yielded 386 metric tons of amber.

The smallest pieces of amber are manufactured into fused amber or resin, amber oil, and succinic acid. Good grades of amber are welded by heat and pressure into solid masses called "amberoid." Large quantities of crude amber go to Polangen and Kretinga, border towns in Russia, for manufacture into ornaments as rosaries, necklaces, cigar-holder tips, etc. In 1910 the Government authorized the sale of 55,000 kilograms of raw amber and 22,000 kilograms of compressed amber, at a value of $788,357.

AMETHYST.

DEPOSITS.

Amethyst has been found at several localities in Macon County, N. C., and in Rabun County, Ga., to the south. Some of the deposits have been opened as mines and others have been prospected only or worked intermittently. At present none of them is in operation. Several prospects and mines have been opened in the valley of Tessentee Creek, in North Carolina, and other deposits have been found a few miles southeast of these, on the south side of the Blue Ridge. Of the deposits in Georgia some are in the vicinity of Clayton and others are about 5 miles south of Highlands. Of the deposits in the valley of Tessentee Creek, the Connally mine has been worked by the American Gem & Pearl Co., New York, and the Rhodes mine by the Passmore Gem Co., Boston. Other prospects for amethyst in North Carolina are located on the lands of William Long, John Justice, and J. B. Justice.

NORTH CAROLINA.

Connally mine.—The Connally mine is on the north side of the valley, about 2 miles N. 55° E. of the mouth of Tessentee Creek, in Macon County. The workings extend over 100 yards northward up a steep mountain side, from an elevation of about 2,600 feet to nearly 2,800 feet above sea level. They consist of prospect pits and tunnels with irregular stopes. Some of the tunnels are over 100 feet long.

The country rock is garnetiferous mica gneiss cut by fine biotite granite gneiss, in both of which pegmatite occurs. The strike of the gneiss as measured in some of the openings was N. 10° to 35° E. and the dip was almost vertical. The amethyst vein cuts across the gneiss with a strike of N. 40° W. and a vertical dip. Local variations in strike occur where the vein follows irregular contacts between the garnet gneiss and the granite gneiss, which, in these places, form the walls of the vein. In other places the vein lies either in garnet gneiss or in granite gneiss. In most of the openings the vein consists of a single seam with pockets of amethyst crystals at irregular intervals. The pockets are more or less lenticular in shape and range from 1 to 12 inches in thickness, and from a few inches to several feet in length. Many of the pockets are filled with yellowish-red and dark-red clay, though some contain cavities. The amethyst crystals line the walls of the pockets, have become detached and lie loose, or are imbedded in the clay of the pockets. Portions of the vein with the pockets and seams joining them form channels for a small flow of water in wet weather, which probably furnishes the clay of the pockets by decomposing the rock along its course. In one prospect two veins were exposed, cutting decomposed granite gneiss. The granite gneiss along one of these veins was more decomposed and more heavily stained with iron than that adjoining the other. The vein in the decomposed rock contained much yellowish-red clay with some amethysts of a fair color. In the other vein only pale amethystine quartz crystals were found.

Seams of small quartz crystals, sometimes in pockets, branch out from the main vein in places, though no amethysts were observed in them.

The amethyst crystals range from a fraction of an inch to over 2 inches in thickness. Most of them have only a pale amethystine color and some are nearly colorless quartz. The purple color of the amethysts is not uniform throughout the crystals, but is generally richest near the points and is often arranged in layers of varying intensity parallel with the crystal faces. Only a small percentage of the crystals yield very dark-purple gem material that will cut into stones weighing several carats.

William Long prospect.—The William Long prospect is between two prongs of the headwaters of Tessentee Creek, 4½ miles east of its mouth. An open cut 30 feet long in an east and west direction with a maximum depth of 8 feet was made on a vein of amethysts. The country rock is granite. The granite on the north side of the cut is partly altered, somewhat porphyritic biotite granite. The granite on the south side and closely connected with the amythyst vein is badly altered and is pinkish yellow. In thin section under the microscope the following minerals were observed in this rock: Quartz in irregular grains and veinlets, muscovite, aggregates of fine decomposition products, apparently sericite, replacing original feldspars, and hematite stains. This rock is probably an altered form of the country granite. The amethyst vein is reported to vary from less than an inch to 8 inches in thickness, and to have an east-west strike with a high northerly dip. No work was in progress at the time of examination, and only the poorer specimens of amethysts were seen on the dump. These consisted of crystals ranging from a fraction of an inch to 1½ inches in thickness. They were mostly pale amethystine in color, though fairly dark-purple crystals are reported to have been found.

Amethyst is reported to have been found on the land of John Justice, about two-thirds of a mile southeast of the Long prospect, and on the land of J. B. Justice, about three-fourths of a mile southwest of the Long prospect.

GEORGIA.

Ledbetter amethyst mine.—The Ledbetter amethyst mine is on Black Creek, 1 mile north of east of Rabun Gap, Ga. The principal workings are on the south side of the creek, and consist of an open cut about 20 feet deep with a shaft 20 feet deep from its bottom, connecting with a crosscut tunnel driven to the vein from the hillside below, a tunnel from the level of the open cut on the vein, and three pits within a distance of 35 yards to the northwest. The country rock is a gneiss that may be flow banded granite or a mica gneiss injected with granitic material, and is badly decomposed and soft. The amethysts are found in one or more veins, which strike about N. 25° W. with a dip of 80° to the southwest. As exposed in one of the workings the vein varies from a seam a small fraction of an inch to over 2 inches in thickness. In another opening there is a double seam with crushed rock and clay between. Where the vein does not carry amethyst crystals it is represented by a seam containing a black stain. Amethysts of good color were found in this deposit.

About 150 yards N. 25° W. of these workings three other small open cuts have been made in the same general direction. The country rock is the same as at the other workings. A number of pale amethyst crystals were seen on the dumps around these pits.

North Georgia Co. mine.—Amethyst has been worked on the land of the North Georgia Co., 4 miles (by road) north of west of Clayton, Ga., on the south side of the Blue Ridge Mountains at an elevation of about 2,800 feet above sea level. The work consisted of an open cut 50 feet long on an amethyst vein, and another cut with a tunnel 60 yards to the northwest. Other prospect pits have been made within 150 yards to the northwest. The country rock is gray granite gneiss, which has a westward strike and low northward dip. There is more than one seam or vein yielding small crystal quartz, but in how many of them amethyst was found could not be ascertained. The crystal quartz veins and amethyst vein have a northwest strike. Only quartz crystals with a pale amethystine color were seen on the dumps, but good gems are reported to have been found during the working.

John A. Wilson amethyst prospect.—A few amethysts have been found on the land of John A. Wilson, 4 miles (by road) southeast of Clayton. The country rock is mica gneiss, inclosing some pegmatite, and striking northwest with a northeast dip. The amethyst vein is accompanied by a silicified zone of rock which cuts the gneiss with a northeast strike and a nearly vertical dip.

TEXAS.

Mr. N. J. Badu, Llano, Tex., has kindly furnished the following notes on the occurrence of amethyst in Llano County. Very little work has been done on any of the deposits and the discoveries so far are not thought to have much value. Few if any crystals have been used as gems. Occasional veins or pockets in soapstone are found that yield 20 to 25 pounds of crystals. A few crystals as large as a man's thumb have been found, but most of them are smaller. Some have a good, deep purple color, but few are very clear.

BERYL.

NORTH CAROLINA

Joel Walker beryl prospect.—The Walker beryl prospect is on a knob one-half mile east of Walker Knob of the South Mountains, 8 miles west of south of Morganton, Burke County, N. C. Beryl crystals have been found at two places here about 200 yards apart. One of these has been opened by a pit 10 feet deep and 18 feet long. This pit is along a pegmatite body striking north and south with an easterly dip. The country rock is mica gneiss cut by granite and has a northeasterly strike. Black tourmaline and small sheets of mica are associated with the beryl in the pegmatite. Both aquamarine and green and golden beryl were found in this opening. At the other locality numerous small yellow and golden beryls up to the diameter of a pencil in size have been found in bowlders of pegmatite on the mountainside. Some of these crystals are clear and have very rich colors. Much of the beryl observed from these deposits was rather badly checked and flawed, though some crystals were seen that would yield cut gems of about a carat in weight. Larger clear stones are reported to have been found. From the small amount of development the showing seems favorable.

Other beryl prospects have been found in the South Mountains. One prospect, a mile east of the Walker prospect, has yielded crystals of good aquamarine color and three-fourths of an inch in diameter, with portions clear enough for cutting.

Littlefield beryl mine.—The Littlefield beryl mine is on the headwaters of Tessentee Creek, 1 mile south of Whiterock Mountain, Macon County, N. C. The last work at this mine was in 1902. The vein was removed by an open cut 135 feet long and from 10 feet deep at the northeast end to 25 feet deep at the southwest end. Another open cut 20 feet long and 10 feet deep, a few feet southwest of the main one, showed that the vein had been offset about 6 feet to the west. The country rock is biotite granite gneiss, porphyritic in places, and strikes N. 40° E. with a 40° SE. dip. The beryls were found in a pegmatite ledge cutting across the granite gneiss with a strike of N. 40° E. and a dip of 85° SE. The greater part of the pegmatite removed in the open cut varied from 3½ to 5 feet in thickness. At the southwest end of the cut the pegmatite pinches down to 8 inches in thickness. Clear aquamarine green and golden beryl, ranging from needlelike specimens to three-fourths of an inch in diameter and 2 or more inches in length, was obtained at this mine. These crystals furnished very beautiful gems as well as some good specimen material.

Beryl crystals are found on a ridge near the house of R. E. Brown, 1¼ miles S. 25° E. of the point where Johns Creek and Caney Fork join in Jackson County, N. C. A small pit was opened in search of mica on the outcrop of a partly decomposed pegmatite. About a dozen beryl crystals were found in this pit. The crystals ranged up to nearly 1 inch in diameter and 2 inches in length. Some of them were transparent in places and of a fairly good aquamarine color. If crystals with larger clear portions and of the same color could be found, they would be suitable for gems.

The beryls are found in kaolinizing feldspar, associated with quartz and a little black tourmaline. The country rock is mica gneiss, badly decomposed, with which the pegmatite seems to be conformable. To the west a short distance is a band of staurolite schist, and to the northeast chloritic soapstone.

GEORGIA.

Beck beryl mine.—The Beck beryl mine is 7 miles due east of Clayton, Ga., a mile or two south of War Woman Creek. The work consists of an open cut 120 feet long and 10 to 15 feet in depth, with three side entries on the downhill side. The country rock is mica gneiss which strikes N. 70° E. and dips 25° N. There are small intrusions of hornblende gneiss in the mica gneiss, and the mica gneiss has local variations of dip and strike around them. The beryl occurs in pegmatite which cuts the gneiss with a north and south strike (dip undetermined). The pegmatite ranges from 6 to 12 feet thick. It carries mica crystals up to 6 and 8 inches in diameter as well as beryl. Much of the mica plates show the "A" structure, though good sheets could be obtained between the "A" lines. Fragments of translucent to subtransparent rough quartz crystals were found in the pegmatite. Bluish, bluish-green, and yellowish-green beryls were found. Some of these measure several inches across and, though badly flawed, contained clear portions suitable for cutting.

NEW YORK.

Mr. Wallace Goold Levison, Brooklyn, N. Y., has kindly furnished the following information on a recent find of aquamarine beryl in New York. The specimens were found by James G. Manchester, 32 Nassau Street, in the Borough of Manhattan. They were obtained in the form of broken fragments without crystal faces and were cut into clear light-blue or greenish-blue aquamarine. One stone of over a carat in weight was cut, but the others were smaller.

UTAH.

The discovery of blue beryl near Ibapah, Utah, is reported by Maynard Bixby, Salt Lake City, to be entirely as float material. Some of the specimens submitted to Mr. Bixby gave evidence of a deposit of gem mineral.

CALIFORNITE (VESUVIANITE).

CALIFORNIA.

Siskiyou County.—The occurrence of massive compact vesuvianite in Siskiyou County, Cal., has been described by George F. Kunz,[1] and the name "californite" was given to it after its native State. The deposit was located by Dr. A. E. Heighway for L. Tannenbaum, of New York. Mr. Amos Clausen, superintendent for the present owners, states that the occurrence of the mineral was known to him before it was located by Dr. Heighway, but that its possible gem value was only partly recognized. The mineral was first called jade, being mistaken for nephrite, until an analysis by F. W. Clarke and George Steiger, of the United States Geological Survey, showed it to be essentially vesuvianite. Massive compact vesuvianite has been found at two localities in the Alps and was there mistaken for jadeite until identified by a chemical analysis by Berwerth. The original locality in California is at present owned by D. C. Collier and S. F. Smith, of San Diego.

The deposit is at an elevation of about 1,700 feet above sea level, on the South Fork of Indian Creek, about 10 miles west of north of Happy Camp. The South Fork of Indian Creek has a northeasterly course and joins the main creek about 2½ miles below the mine. The creek flows east for a short distance at the mine, and is in a narrow valley with steep sides. A good road was made to the mine, but

[1] Gems, jewelers' materials, and ornamental stones of California: Bull. State Min. Bur. California No. 37, 1905, pp. 93–95.

has been broken down by hillside slides in two places. The country is well timbered and watered. The californite outcrops on the north side of the creek on a steep hillside about 75 feet above the water.

The country rock is principally serpentine, varying in color from gray, green, yellowish-green, greenish-black, to black. The serpentine is full of slickenside seams and joints and has been broken and sheared into lens-shaped blocks and masses. These lenticular-shaped bodies range from a fraction of an inch to several feet in thickness and length. Streaks and lens-shaped masses of a granular gray rock are included in the serpentine in the region near the californite deposit. By alteration, not surficial, these rocks assume a greenish cast and appear to grade into californite. The outcrops of this rock measure 20 feet across in places and range down to streaks a few inches in thickness. The californite occurs in lens or pod shaped masses in the serpentine. The lenses follow the bedding of the serpentine and occur at irregular intervals. They range in size from a few inches to 10 feet in thickness and their length is probably two to four times their thickness. The lenses are not regular in shape, but in some cases pinch out and swell or are curved. The several outcrops of the californite in a line along the hillside give the appearance of a vein or ledge of this material. The strike of the californite and inclosing serpentine is about northeast and the dip 10° to 40° NW. About half a mile below the mine a mass of dense bluish-black rock is inclosed in the serpentine. Under the microscope this is found to consist largely of quartz penetrated by innumerable needles of blue glaucophane.

The californite has been traced nearly 100 yards from the main outcrop along the hillside in a north-of-east direction. The principal work consists of an irregular open cut, or set of cuts, nearly 200 feet long on the lower side of the outcrop with two short tunnels in and under the masses of californite. Several pits have been made farther east. A number of large masses of californite lie in Indian Creek below the deposit, from which large blocks have become detached and rolled down. They have since been rounded into bowlders by attrition in the creek. These bowlders range in size up to 6 feet long and 3 feet thick, and have yielded some very good grade of gem material. There is considerable matrix associated with the californite in the bowlders as well as in the original deposits. The grade of the californite is also quite variable, even in the same masses, some being translucent light to dark green, and others opaque greenish-gray to gray. The californite is associated with both granular gray rock and with serpentine. It is attached to both rocks and in places appears to grade into either. In some places the californite occurs in masses over a foot thick with good color and translucent. Masses of poorer grade are in some places several feet across. Seams and joints or cracks are common in all varieties of californite, so that masses of good grade several inches thick without flaws are rare. Many of the cracks have been recemented or were not sufficiently pronounced to weaken the mineral materially so that the californite can be cut regardless of them, if large pieces are desired for ornamental use. Other seams are due to joints strongly developed, with or without a deposit of other mineral on them, forming planes of easy fracture in the californite. The californite is grayish green to yellowish green to dark green and some has almost a bright-green color. Much of it is translucent and some of the better grades are highly so. In places the translucency is slightly clouded. The bright green generally occurs in splotches and tufts through paler-colored mineral. In places the patches of green are so plentiful that whole masses of the californite are strongly colored. Californite is very tough and has a hardness of about 6.5. The specific gravity of the Siskiyou County californite is 3.286, nearly as great as jadeite and greater than jade or nephrite. The specific gravity of material from Fresno County is 3.359. It takes a high polish and is adapted to many purposes for which jade is used. The flocculent appearance and texture of the californite increases the resemblance to jade.

Henry Wood, of San Francisco, and Justice Brown, of Happy Camp, own a claim for californite adjoining that of Collier and Smith on the northeast. Outcrops of large ledges of altered granular gray rock have been blasted into in search of gem material. They own two principal ledges of the rock outcrop, one at about 50 feet higher than the creek and the other about 100 feet. The country rock is the same variety of serpentine as at the mine just described. The outcrops of the gray parent rock of the californite are from 10 to 20 feet thick and are lenticular in shape. Large portions of this rock have a greenish color and are composed of finely fibrous mineral in a felted mass. Much of the californite at this prospect is low grade, but some fairly good colored translucent material was seen on the dumps.

Specimens of white californite, given by Mr. A. Clausen, of Happy Camp, were described in this report for 1909. The material was obtained from bowlders found in Indian Creek. Specimens of the same variety of californite were recently received from Mr. Felix Busse, Happy Camp, and may have come from the same locality. They were evidently broken from bowlders, as some of the specimens show surfaces worn by attrition. The material is quite translucent and has a waxy luster. The color is pure grayish white to gray with a faint tinge of green and an occasional patch of grass green. The fracture, hardness, grain, and toughness are the same as in the green californite, and the mineral ought to be a good substitute for white jade, which it closely resembles and which is in demand by the Chinese. If material in which the bright green patches were more plentiful could be found, it would rival the best qualities of jade. It is not possible definitely to distinguish the massive white variety of vesuvianite from massive white garnet without a detailed chemical analysis, since the two minerals are so similar in both physical and chemical properties. Analyses of the vesuvianite variety of californite and white garnet by Clarke and Steiger [1] bring out the similarity, but indicate a possible method of discrimination without a detailed analysis by the presence of from 3.42 per cent to 4.18 per cent of water in the vesuvianite, and of 0.80 per cent of water in the garnet. A determination of the water content by ignition, by Dr. R. C. Wells, of the United States Geological Survey, gave 1.38 per cent in the white californite given by Mr. Clausen and 1.05 per cent in that given by Mr. Busse. The results are not conclusive, but are indicative of garnet rather than vesuvianite. The specific gravity of the vesuvianite variety of californite is given as from 3.286 to 3.359 and that of white garnet as 3.586. A determination of the specific gravity of the

[1] Clarke, F. W., and Steiger, George, On "californite:" Bull. U. S. Geol. Survey No. 262, 1905, pp. 72–75.

Siskiyou County white mineral, by Dr. J. E. Pogue, of the National Museum, gave 3.57—further evidence in favor of garnet. The minerals, garnet and vesuvianite, may be so intimately mixed in some varieties of californite that an absolute determination is not possible. The idea of the development of two minerals with such similar properties and composition together seems within reason. The term californite may be used both for massive compact vesuvianite and for garnet when these can not be readily distinguished.

Butte County.—A deposit of californite was worked by the North California Mining Co., of Oroville, near Pulga post office or Big Bar station on the Western Pacific Railway near the Butte-Plumas County line. E. A. Jackson, vice president of the company, states that the deposit is in the southwestern part of T. 25 N., R. 8 E. Considerable crude californite was mined during 1910, but a small per cent only was suitable for cutting. The demand for californite for jewelry was limited and the quantity sold was not large. Specimens of the californite, kindly furnished by Mr. Jackson, were translucent apple green, showing in places a few darker green patches. The color is not so dark as that of the Siskiyou County californite, and resembles closely some of the Fresno County variety. The color is rather evenly distributed and pleasing. A better trade for the material has been reported during the first part of 1911.

DIAMOND.

ARKANSAS.

The following notes are abstracted from an article by John T. Fuller,[1] general manager of the Arkansas Diamond Co.:

Contrary to expectation there was but little development on the company's property during 1910, due to continued lack of capital. The production of diamonds in the Arkansas fields amounted to about 200 stones, all of which came from the one peridotite outcrop, the greater part of which is controlled by the Arkansas Diamond Co. The total production to date is estimated at about 1,200 stones, weighing approximately 574 carats. Of this production 1,179 stones came from the original peridotite area. During 1910, 145 loads of earth of 16 cubic feet were washed in a small test plant at the mine, and yielded 142 diamonds weighing 53.56 carats, or an average of 0.369 carat per load. In addition, 44 stones weighing 20.5 carats were picked up on the surface. The outlook for extensive development in 1911 is not promising.

Mr. Reece Lamb, first vice president of the American Diamond Mining Co., gives the following information about diamonds found on the company's land:[2]

Twenty-two diamonds have been found, 7 in 1908 and 14 in 1909, with 1 stone found by an outside party in the latter part of 1908 or early in 1909. No diamonds were found on the property during 1910. The area of the peridotite has been proven, but no washing machinery installed.

In regard to the holdings of the Kimberlite Diamond Mining Co., Austin Q. Millar [3] says:

"Kimberlite" rock has been found on the property about one-fourth of a mile west of the American Diamond Mining Co.'s mine. Mr. Millar claims that sworn statements were made by Oliver Cummings Farrington and Philip F. Schneider to this effect at Murfreesboro in 1908. A few small diamonds have been found, but all were white stones. No washing has been undertaken and the property is being tested to determine the size of the peridotite.

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[1] Eng. and Min. Jour., Jan. 7, 1911.
[2] Personal letter, dated Murfreesboro, Ark., Jan. 30, 1911.
[3] Personal correspondence, dated Apr. 4, 1911.

CALIFORNIA.

A number of diamonds have been found in California, especially in Butte County, and some of the discoveries have been described.[1] Several diamonds were reported as being found during 1910 in the Cherokee Flats region, and two of these were mentioned in this report for 1909. One of these two diamonds weighs about half a carat and the other between 1¾ carats and 2 carats. The latter is a brilliant, clear, flawless stone with a tinge of yellow. It is a much rounded crystal with curved faces, either a trisoctohedron or hexoctohedron. This diamond was kindly shown to the writer by Mrs. James, of Cherokee. Both diamonds were found among the old hydraulic workings during placer mining on the land of T. L. Vinton, by a miner named George Stone. The residents of Cherokee Flats state that over 200 diamonds have been found which have generally been picked up by parties interested only in gold.

All the diamonds so far found in California have come from gravel deposits. Search for diamonds in the original rock matrix has been carried on by the United States Diamond Mining Co., of Oroville, under the direction of M. J. Cooney. This company owns property near Oroville, at Cherokee Flats, and at other places in the region. The principal work has been on the property about 1 mile north of Oroville. This consists of about 40 acres in part covered by alluvium, 10 to 15 acres having been stripped off by earlier hydraulic mining. Developments by the present company consist of a 300-foot shaft, a 60-foot shaft, and numerous small pits. To facilitate hydraulic mining in the early days a drainage tunnel was cut from the placers under bedrock to the bank of Feather River. This tunnel was used to remove the débris from mining and is still open. Several small diamonds are reported to have been found on this property, but none were kept in the possession of the company.

The alluvium has a thickness of about 50 feet in places and has been left standing in walls around the old placers. The bedrock now exposed is decomposed and is yellowish gray in color. In the excavations it is observed passing into bluish to greenish rock. Tufa-like segregations and balls of limestone occur in the decomposed rock and give place to calcite seams in the less altered rock below. At the mouth of the drainage tunnel a decomposed sedimentary rock is exposed, carrying brachiopod fossils so badly weathered as to be indeterminate.

Prominent among the rocks of the Oroville region, as mapped by Turner, Lindgren, and Becker,[2] are a series of amphibolite schists derived from various basic rocks as gabbro, diorite, diabase, etc. Some augite porphyrite is included in the schists. These rocks are older than late Cretaceous. From the bridge north of Oroville a section along Feather River and the Western Pacific Railway track reveals rock formations answering the above description. The formation on the property of the United States Diamond Mining Co. is very similar in appearance to that observed along the river, and some of the less decomposed material from the shafts appears to be identical. Specimens from both places are considerably serpentinized and

[1] Turner, H. W., Diamonds in California: Am. Geologist, vol. 23, 1899, p. 182.

[2] Marysville folio (No. 13), Smartsville folio (No. 18), and Bidwell Bar folio (No. 43), Geol. Atlas U. S., U. S. Geol. Survey.

contain epidote, zeolite, etc. In thin section under the microscope some of the specimens show basic feldspars in various stages of alteration and enough of the minerals and texture could be identified to class the original rock as gabbro in some cases and diabase in others. The general appearance of these rocks resembles serpentine, and the weathering, also, is similar to that of serpentine.

The property owned by Mr. Cooney and his associates at Cherokee Flats includes a number of acres of old placers where a quantity of diamonds are reported to have been found. Prospect pits and a 60-foot shaft have been made. The shaft encountered banded black slate. Buff to gray sandstone and slate outcrop in other parts of the old placers. These sedimentary rocks appear to be interbedded with diabase and amphibolite. The latter rock, in certain places, is very similar in appearance to the rock of the Oroville region. It outcrops in large flattened spheroidal bowlders of weathering.

Since the presence of diamonds is well established in Butte County, the original matrix remains to be located. The recent discovery of diamonds in peridotite in British Columbia may furnish a clue as to the nature of the rock to be examined for diamonds in California. It has never been proved that a peridotite is the only type of rock in which a diamond can occur, and some of the other basic rocks of California may prove to be diamondiferous. However, the serpentinized amphibolites may contain masses formed from original peridotites or allied rocks that have served as a matrix of the diamonds found in the placers. The possibility of reworking the old placers for diamonds ought to be considered, also, for they have never been tested with this in view. Mining operations heretofore were adapted only to the saving of gold, and only an occasional diamond was caught in the riffles of the sluice boxes.

CANADA.

The discovery of diamonds in British Columbia has been announced by R. W. Brock,[1] director of the Canada Geological Survey. Charles Camsell, of the Canada Geological Survey, was engaged in a geological examination of the Tulameen River region and submitted samples of chromium ore from Olivine Mountain to R. A. A. Johnston, a mineralogist of the Canada Survey, for determination of the chromium minerals. During the investigation Mr. Johnston obtained fragments of an insoluble mineral which proved to be diamond. The specimens separated have all been small or microscopic in size, but under the microscope many appear to be clear and of good quality, but some are yellow and brown. The diamonds have been found in chromite which occurs in small irregular veinlike segregations and disseminated grains through the olivine rock. Gold and platinum also occur in the chromite. The peridotite with which the diamonds are associated is altered to serpentine in places, thus giving a matrix somewhat similar to that in which diamonds have been found in Africa and Arkansas.

Dr. Brock obtained small crystals thought to be diamond from British Columbia several years ago, but the material was lost before complete tests could be made, and the results were therefore not

[1] The Citizen, Ottawa, Canada, Mar. 16, 1911.

published. The prospectors were given a hint at that time, however, to be on the lookout for diamonds in British Columbia. The discovery is regarded as of scientific interest only, but the possibility of finding larger stones in the gravels should not be overlooked.

SOUTH AFRICA.

Cape Colony.—The output of diamonds by the De Beers Consolidated Mines [1] shows a large increase in 1910 over the two preceding years. Although no statement is given of the number of carats of diamonds produced in 1910, estimates based on such figures as are given show an output of approximately 2,661,223 carats, as compared with about 1,863,838 carats in 1909. These estimates are based on the number of loads of blue, cylinder lumps, and tailings washed from each mine and the yield per load. During 1910, 6,684,156 loads of blue were washed, as compared with 4,774,172 loads in 1909. The total production of blue ground in 1910 was 5,111,524 loads, as compared with 3,557,975 loads in 1909. The stock of blue ground and cylinder lumps was reduced from 9,526,531 loads in 1909 to 7,776,059 loads in 1910. The value of the diamonds sold and of stocks on hand at cost of production was £5,414,896, as compared with £3,074,912 in 1909. The value of the diamonds produced in 1910 is less than that of 1907 by £1,037,701. The De Beers and Dutoitspan mines closed down during 1908. Work on the Dutoitspan was resumed in January, 1910, but work on the De Beers mine has not yet been resumed. Blue ground from the floors of all the mines, including the De Beers mine, was washed. The yield in carats per load of blue washed decreased from 0.42 to 0.38 at the De Beers and Kimberly mines, from 0.34 to 0.32 at the Wesselton mine, and from 0.38 to 0.37 at the Bultfontein mine. The yield per load of blue washed at the Dutoitspan mine was 0.23 carat, the same as in 1908.

Attention is called to the fact that in value the De Beers company produces 48 per cent of diamonds mined in South Africa, including German Southwest Africa. The Jagersfontein mine produces 7 per cent, the Premier less than 20 per cent, and other companies, including the river diggings, produce the remaining 25 per cent of the value of the output.

The total production of diamonds in Cape Colony [2] in the calendar year 1909, reported by the detective department, amounted to 2,527,297 carats, valued at £4,690,478, as compared with 1,588,511 carats, valued at £3,085,352 in 1908. This production came from the districts of Kimberly, Barkly West, Hay, and Herbert, and from alluvial diggings on Vaal River.

Transvaal.—According to Consul Edwin N. Gunsaulus,[3] of Johannesburg, the annual report of the Premier Diamond Mining Co. for the year ending October 31, 1910, showed a production of 2,145,833 carats of diamonds, valued at $7,283,398, or a value of $3.39 per carat. An average yield of of 0.23 carat per load, valued at 78½ cents, was obtained from the 9,331,882 loads of earth washed. The profits for the year amounted to $2,633,709, of which 60 per cent is claimed by the Government. The production shows an increase over 1909 of 73,696 carats in quantity and of $1,578,020 in value.

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[1] Twenty-second Ann. Rept. De Beers Consolidated Mines for year ending June 30, 1910.
[2] Report Surveyor General Cape of Good Hope, 1909; Dept. of Agriculture.
[3] U. S. Daily Cons. Repts., Apr. 11, 1911.

German Southwest Africa.—The production of diamonds in German Southwest Africa in 1910 is estimated by Consul General Henry W. Diedrich,[1] of Antwerp, at about 800,000 carats, with a value of about $6,000,000. Official figures of the German Diamond Regie,[2] however, show a production of only 92,619 carats for the third quarter of 1910. The majority of the German diamonds go to Antwerp, but a few are now being cut in Amsterdam. Some are cut in Germany. Competition of the German diamonds and those from the Premier mine with the product of the De Beers mines has resulted in a reduction in the price of low-grade stones and of bort for industrial purposes. Bort diamonds, formerly sold for $1.67 to $1.90 per carat, have been reduced to about $0.60 per carat.

According to Herr Baderman, in the Deutsche Goldschmiede Zeitung,[3] an analysis of the color of 1,558 German diamonds gave the following results: Clear, or with a slight yellowish tinge, 819; delicate yellow, 136; lemon yellow, 87; light pink, 116; dark red, 9; bluish, 30; greenish, 5; blackish, 9; showing various colors, 68; impure or turbid shades, 62; split diamonds, white or pink, 217. The German Southwest Africa diamonds do not present any marked difference from those of South African diamonds generally, with the exception of size.

SOUTH AMERICA.

British Guiana.—The exports of diamonds from British Guiana[4] during the calendar year 1910 amounted to 3,808 carats, valued at $30,946, as compared with 5,646 carats, valued at $36,069 in 1908. The value given the production of 1909 in a previous report was $39,060.

INDIA.

The production of diamonds in India[5] in 1909 amounted to 147.35 carats, valued at £1,089, as compared with 140.75 carats, valued at £940, in 1908. Of the production in 1910, 111.37 carats, valued at £47, came from the Madras Presidency and the remaining 35.98 carats, valued at £1,042, from the Central Indian States.

AUSTRALIA.

New South Wales.—The production of diamonds in New South Wales[6] during 1909 amounted to 5,474 carats, valued at £3,959, as compared with 2,205 carats, valued at £1,358, in 1908. The total production since 1867 is estimated at 167,354 carats, valued at £111,462.

DIAMOND INDUSTRY.

Antwerp.—The following notes on the diamond industry in Antwerp are abstracted from a report by Consul General Henry W. Diederich:[1] The trade in diamonds in Antwerp in 1910 might be considered a good average one. The exports to the United States,

[1] U. S. Daily Cons. and Trade Repts., Feb. 25, 1911.
[2] Consul General Frank D. Hill, Jewelers' Circ. Weekly, Jan. 4, 1911.
[3] Manufacturing Jeweler, Feb. 9, 1911.
[4] Min. Jour., London, Feb. 4, 1911.
[5] Rec. Geol. Survey India, vol. 40. pt. 2, 1910.
[6] Ann. Rept. Dept. Mines, New South Wales, 1909, p. 53.

the principal market, were large during the first part of the year, but fell off during the last part. The demand in the United States, formerly always for larger perfect stones, changed in part for many of smaller size and of second quality, as the price was raised by the London syndicate. The London syndicate raised the price of large stones, in which it had a monopoly, to offset the loss it suffered by the reduced price offered for smaller stones, due to the large production of such stones in German Southwest Africa. The small diamonds offered by the London syndicate were at a price 30 to 40 per cent higher than those offered by the German regie. The London syndicate advanced its price, on all stones over one-fourth of a carat in weight, from 5 to 10 per cent.

There were labor difficulties in Antwerp due to the very strict rules of syndicated workmen in allowing apprentices to learn the trade. Some of the workmen who recognized the need of increasing the number of cutters and were not allowed to teach their own sons the trade, withdrew and opened new lapidary shops in the vicinity of Antwerp and in other places in Belgium. The new enterprises found ready employment in cutting the German diamonds. The number of cutters in Antwerp rose from about 5,000 to about 12,000, who received an average wage of about $20 per week. Antwerp has led in the exportation of diamonds to the United States during the last two years. The exports from Amsterdam were nearly as large, and for many years prior to 1909 they were greater than those of Antwerp.

Amsterdam.—The diamond industry of Amsterdam has been reviewed by Consul Frank W. Mahin.[1] About 70 establishments in Amsterdam cut and polish diamonds. More than 10,000 people are employed in the trade, of whom about 1,700 are cleavers and cutters, 4,700 polishers, etc., and the remainder are engaged in other work about the offices. The workmen are divided into five classes, cleavers, polishers, turners, cutters, and sawyers. The wages range from as much as $120 per week for the best cleavers to $6 per week for sawyers. The diamond workers of Amsterdam have a close organization and admit only a few new workmen under strict examinations and instruction. A beginner must be under 18 years of age, have good eyesight, and generally has to pay well for his instruction. There are some cutters outside of the organization, and the numbers are growing.

Cullinan diamond.—The setting of the larger stones cut from the Cullinan diamond [2] in the scepter and crown of King George has been reported. The largest stone has been placed in the scepter and the next smaller one in the crown. Both stones can be removed from their mountings and worn as pendants by the Queen. The first use of these stones was at the time of the coronation of King George in Westminster Abbey in June, 1911.

Hope diamond.—The famous Hope blue diamond has changed hands several times during the last decade. It was purchased from the Hope estate by Joseph Frankels & Sons [3] and brought to the United States in 1901. Mr. Habib, of Paris, a Persian collector, purchased the gem in 1908. In June, 1909, it was advertised for sale along with other

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[1] U. S. Daily Cons. and Trade Repts, Apr. 1, 1911.
[2] Manufacturing Jeweler, Dec. 15, 1910.
[3] Jewelers' Circ. Weekly, Dec. 21, 1910.

gems belonging to Mr. Habib and was reported to have been purchased by a Paris syndicate at that time. On November 23, 1910, the big blue diamond was again brought to the United States to the New York branch of the French firm of Cartier. A sale of the gem for $180,000 to Mr. Edward B. McLean, of Washington, D. C., was arranged.[1] Later suit was brought by the firm of Cartier for the fulfillment of the contract of sale, which Mr. McLean did not deem valid, since, as he maintains, he was falsely informed that the Hope diamond had never been sold for less than $250,000 previously. The suit is now in the courts.

Brazilian diamond.—According to Roderic Crandall,[2] a geologist of the Brazilian Geological Survey, a large diamond weighing 35.874 grams, or 179.37 metric carats, was sold in Rio de Janeiro in 1910. The price was equivalent to about $175,000. The diamond came from Bagagem, Minas Geraes.

Metric carat.—The number of governments that are adopting the metric carat of 200 milligrams is increasing. The law establishing the metric carat in France [3] was scheduled to take effect on January 1, 1911. An Italian law of July 7, 1910, provides that the metric carat [4] shall be used in the sale of pearls and diamonds. The use of the term carat for any other weight than 200 milligrams is prohibited. A law was scheduled to take effect in Roumania on January 1, 1911 (old style), establishing the use of the metric carat as the weight by which diamonds, fine pearls, and precious stones should be sold. Steps are being taken for the adoption of the metric carat in the Netherlands.[5] A similar law has already been proposed in Belgium. An agreement was made by jewelers and lapidists in France, Switzerland, Norway, Roumania, Bulgaria, and Spain [6] to work for the adoption of the metric carat by their respective countries as a means of simplifying trade in precious stones.

DIOPSIDE.

CALIFORNIA.

Specimens of lilac-colored pyroxene, found in the vicinity of San Francisco, were kindly furnished by Mr. J. J. Kinrade. This material has been cut for gems and ornaments under the name of pink wollastonite. The mineral occurs as fibrous and columnar radial aggregations and in seams in a dull grayish-green rock. Both purple and green minerals occur in patches of light and dark color and with them are areas of nearly pure white. The contrast of colors with the good polish to which the whole rock is susceptible is pleasing. An examination of the optical properties of the mineral by E. S. Larsen, of the United States Geological Survey, shows it to be not wollastonite, but a variety of pyroxene, probably diopside. A partial chemical analysis by George Steiger, of the Survey, also indicates the mineral to be diopside. The associated greenish minerals were only partly determined under the microscope, and consist of felted fibrous masses and stout crystals of a pyroxene, diopside or augite, actinolite, etc.

[1] Jewelers' Circ. Weekly, Mar. 15, 1911.
[2] From a lecture on Brazil before Pick and Hammer Society of the U. S. Geol. Survey, Washington, D. C.
[3] Jewelers' Circ. Weekly, Nov. 23, 1910.
[4] Manufacturing Jeweler, Sept. 22, 1910.
[5] Jewelers' Circ. Weekly, Aug. 24, 1910.
[6] Manufacturing Jeweler, Feb. 16, 1911.

ARIZONA.

Actinolite with a clear light-green to deep emerald-green color is found associated with the peridot north of Fort Defiance, Ariz. This material has been commonly mistaken for diopside and has been called chrome diopside in several reports, and was so designated in this report for 1908. The attention of the writer was called to this error by Mr. J. E. Sheridan, United States mine inspector, and tests were made proving the correctness of Mr. Sheridan's claim. Tests were also made on similarly colored mineral found with the Navajo garnet in northern Arizona and with the peridot near Rice, Ariz. These minerals were found to be diopside, however, and to contain an appreciable quantity of chromium. Mr. Sheridan has had some of the emerald green actinolite crystals cut. They yield beautiful gems, but are rather too soft for jewelry exposed to rough usage.

EMERALD.

NORTH CAROLINA.

The discovery of a new emerald prospect in North Carolina during 1909 on the land of W. B. Turner, 4¾ miles S. 30° W. of Shelby, in Cleveland County, was described in this report for that year. A few additional notes were obtained in December, 1910, and are given here with a summary of the former description. The first emeralds were found loose in the soil of a cotton field, some ten or a dozen crystals being found before any prospecting was started. Some of these emeralds were of very good color, and of fairly good quality. A few of the cabochon and drop-shaped gems cut from them have proved very pretty mounted in a necklace. A few faceted stones cut from these crystals have also been admired.

The locality is a hillside of moderate slope about 30 feet higher than the First Broad River near by. The elevation is about 680 feet above sea level. The rocks of the region 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 rocks are varied. There are mica, cyanite, garnet, and hornblende gneisses, and schists cut by granite or quartz monzonite, gabbro, diorite, amphibolite, and pegmatite. The emerald occurs in pegmatite cutting amphibolite. The amphibolite is associated with a mass of basic rock which presents two phases, oblivine gabbro and diorite. These rocks are in turn inclosed in biotite granite, and the latter rock includes masses and balls of the more basic rocks near the contact of the two. The several rocks are more or less decomposed near the emerald prospect and some phases of the decayed gabbro and amphibolite are difficult to distinguish from one another. The basic rocks make a dark, reddish-brown clay soil on thorough decomposition, and the granite gives a lighter-colored generally sandy soil. Minerals associated with the emeralds are albite, quartz—clear, colorless, and smoky—with black tourmaline, and actinolite inclusions, black tourmaline, and common green beryl crystals.

At the time of the last examination there were five openings and two small ones that had been filled up. The largest working consisted of a trench over 100 feet long and from 2 to 12 feet in depth. The next largest opening, about 7 feet east of the trench, was a pit

15 feet long, 9 feet deep, and 7 feet wide. All of the workings were within a space of 50 feet and were in an east and west direction from one another. Decomposed and partly chloritized amphibolite and gabbro were encountered in each cut. In the largest trench four or five pegmatites were cut, most of them being small. Emeralds were found in one pegmatite only, the other pegmatites containing only quartz and tourmaline crystals. Veinlets of quartz crystals, with little if any other mineral, cut the amphibolite. Some of the quartz crystals from these veinlets are very clear and measure 2 inches through. Part are colorless and part smoky brown. The pegmatite carrying the emeralds is lens-shaped with irregularities in direction. In the larger pit it was 30 inches wide at the surface on the east side of the pit and 18 inches wide on the west side. At a depth of 10 feet the pegmatite was about 18 inches wide. An offset or overlapping lens of pegmatite was exposed in the east face of the pit near the surface. The pegmatite has an irregular strike approximating east and west and a dip of 80° N.

The gem-bearing pegmatite is medium to coarse grained and 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 crystallization of the minerals of the pegmatite is not good, but a few partly developed crystals are found in small irregular miarolitic cavities. Crystals found in these cavities are colorless and smoky quartz, albite feldspar, black tourmaline, and a little 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. Some of the emerald crystals are firmly attached to other minerals and others are loose and may be obtained by washing the semidecomposed pegmatite. Many small fragments and crystals of emeralds have been found this way, but up to 1911 only a very few pieces of gem emerald had been found in place in the rock, nearly all the gem material having come from the surface.

Mr. George L. English, who has assisted Mr. Turner in prospecting for the emeralds, has kindly given the following information [1] on the latest developments at the mine. The main pit has been sunk to a depth of 15 feet on the pegmatite and another pit a few feet to the east has also exposed the "vein." In this pit the pegmatite was about 5 feet wide and had a dip of 15° to 20° E. A trench about 10 feet deep and nearly 30 feet east of the main pit has also cut the "vein." Several other prospects on the place have shown the presence of pegmatite but failed to develop emeralds. At one of these prospects, an eighth of a mile southwest of the main locality, an abundance of fine black tourmaline crystals, a little dark green apatite, two unidentified minerals—one a metallic mineral and the other a dark resinous one—and a blue mineral resembling crocidolite were found.

In the main pit a large pocket of emerald crystals was found at a depth of about 10 feet. Most of these were pale in color, but some were nearly equal to the pieces found on the surface. Only a few

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[1] Personal letter dated Shelby, N. C., June 2, 1911.

small pieces have been cut, and a faceted stone among these was sold at the rate of $48 per carat. The largest crystal found measured $2\frac{1}{4}$ inches long by five-eighths of an inch in diameter, and weighed 26.2 grams. This crystal was broken into four pieces. The color, except near the termination, is pale and the crystal is deeply striated so that its color does not appear so strong as on broken surfaces. Many of the crystals from this part of the "vein" are opaque inside, but have their transparent shells of rich green color that would cut into good faceted stones of small size.

SOUTH AMERICA.

Notes on the rediscovery of certain lost emerald mines in Colombia have been given by E. B. Latham.[1] Emeralds were highly prized by the Indians of South America and were mined by them for centuries prior to the coming of the Spanards in three districts of the present Republic of Colombia. These districts, Muzo, Cosquez, and Somondoco, were widely separated. When the Spanish took possession of the country about 1555, the emerald mines also were taken up. Excessive cruelties were practiced by the Spanish mine workers on the Indians employed in the mines. The trouble was not averted by the importation of African negroes, and in the war of independence of 1816 following, the country was so desolated that the mines of Cosquez and Somondoco were entirely lost. From that time until recently the Colombian emeralds have been obtained only from Muzo. A Colombian named Francisco Restrepo, guided by a few hints given in ancient Spanish parchment maps, and with little or no knowledge of geology or emeralds, undertook the search for the lost emerald mines. In 1896 he found traces of ancient workings and later the large workings of the lost mines. The mines are situated on a sectional ridge of the great eastern range of the Andes Mountains, at an elevation of about 9,000 feet above sea level. An old ditch 12 to 15 miles long, with reservoirs above the mines, was found. The great open cuts and tunnels were scattered over an area 6 miles long east and west and 3 miles wide north and south. Some of the working faces of these mines measure 700 to 300 meters on steep slopes; of this about 100 meters is emerald-bearing and the rest nonproductive. The emerald region is covered by forest and jungle, which doubtless conceal other workings in the region. The climate is about that of perpetual late autumn.

AUSTRALIA.

New South Wales.—The emerald mine at the Glen in the Emmaville Division, New South Wales,[2] was reopened during 1908. About 1,000 carats of emeralds, valued at over £1,600 were obtained. The largest stone weighed 60 carats in the rough. The largest stone obtained in a parcel of cut emeralds weighed 6 carats. Some of the emeralds are of good quality, but the majority are pale colored.

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[1] School of Mines Quart., vol. 32, 1911, pp. 210–214.
[2] Ann. Rept. Dept. Mines New South Wales, 1909, p. 54.

GARNET.

NORTH CAROLINA.

Garnet crystals for abrasive purposes and occasional gems have been obtained from a deposit 8 miles in a southeasterly direction from Morganton, along Laurel Creek, Burke County, N. C. They are a calcium free, iron magnesium garnet belonging to the pyrope type. The color is a deep pink to rich wine red, and some good gems, especially for carbuncle cuts, have been obtained from them. These garnets occur in slightly graphitic schist, which is both micaceous and cyanitic in places, and is a member of the Carolina gneiss. They are closely associated with a pyroxenite rock and occur in the schist at or near the contact with this rock. The pyroxenite occurs in lenticular and rounded masses of various sizes in the schists. These masses range from less than a foot across up to many yards in thickness. In many cases the pyroxenite has altered to chloritic soapstone to a depth of several feet from the surface. There has been contact action between the pyroxenite and inclosing schists, as shown by the presence of chlorite zones between them.

The garnets occur scattered through or in streaks in the schist, either at the contact with the pyroxenite or at a distance of several feet from it. The garnets range in size from a fraction of an inch to 3 or 4 or more inches in diameter. Many of them, especially of those near the surface, have been badly decomposed, and in some cases entirely so, and have passed into reddish-brown earthy masses. The garnet occurs in the bedding of the schist which they have forced apart, so that it assumes an augen shape around the crystals. This augen effect is very striking in some cases where small masses of kaolinized feldspar occur in the augen on each side of the garnet.

Rhodolite is the name given by Hidden and Pratt [1] to the rose pink garnet found in Macon County, N. C. Attention was called to this garnet in 1893 by A. M. Field, of Asheville.[2] For several years it was supposed to be a variety of almandine, until analysis showed that its composition is equivalent to two molecules of pyrope and one of almandine. It was accordingly given the varietal name rhodolite by the analysts, from the Greek words equivalent to rose stone. Rhodolite ranges in color from pale rose pink to dark rose pink, and some of the gems have a purplish cast. As the clear rhodolite garnets are exceptionally free from inclusions, they are very brilliant and display their color well. Large garnets are not plentiful, though stones weighing as much as 14 carats [3] have been cut. Dr. Kunz estimates that about $53,000 worth of these garnets have been sold.

The principal locality from which rhodolite garnets have been obtained is in the valley of Mason Branch, about 5 miles north of Franklin. The gem has also been found associated with ruby in Cowee Valley, and occasionally stones of a size sufficient for cutting have been obtained when mining for ruby. Pink and purplish garnets, some with practically the same color as rhodolite, though generally of a dark shade, have been found in other parts of Macon and Jackson counties. It is sometimes difficult to distinguish between

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[1] Hidden, W. E., and Pratt, J. H., Rhodolite, a new variety of garnet: Am. Jour. Sci., 4th ser., vol. 5, 1898, pp. 294–296.

[2] Kunz, G. F., History of the gems found in North Carolina: Bull. North Carolina Geol. and Econ. Survey No. 12, 1907, p. 50.

[3] Op. cit., p. 51.

the dark-colored rhodolite and the light-colored almandine with a pink or violet color.

The rhodolite garnet deposits in the valley of Mason Branch were worked from 1893 to 1901, inclusive. Most of the gem garnets were obtained from the gravel deposits along the branch where both sluicing and hydraulic mining were carried on. A dam was constructed across the branch to secure water for these operations. Many of the garnets from the placer deposits consisted of nearly pure gem material, the fractured portions of the originally larger garnets having been removed by attrition in the stream gravels, leaving only hard pebbles and fragments of solid garnet. As associated minerals Hidden and Pratt[1] mention—

> quartz, rarely as isometric pseudomorphous dodecahedrons; small rough garnets of a dark pyrope nature; small corundum crystals of pale blue, amethystine, and pink shades, sometimes with a distinct ruby tendency; spinel, the pleonaste and gahnite varieties; bronzite, transparent; iolite, colorless; cyanite; fibrolite; hornblende; staurolite (often clear and glassy); rutile; menaccanite; chromite (rare); monazite (rarely green); zircon; gold and sperrylite in minute quantities

Some of these minerals are more completely described in a later publication.[2]

The better portions of the placer deposits were worked out in 1901 by the American Gem Mining Syndicate. During the operations of this company prospecting was carried on for rhodolite in the matrix in the surrounding region. Some measure of success was met with in the prospects on the north side of the valley of Mason Branch, especially near the summit of a knob where three openings were made. The rhodolite here occurs disseminated through mica schist or gneiss in crystals ranging from a small fraction of an inch to over 3 inches in diameter. The crystals are inclosed in biotite, quartz, and other minerals of the rock. The rhodolite replaces irregular masses of biotite and occurs in lenticular wrappings of biotite flakes. Small flakes of biotite and grains of quartz are inclosed in some of the garnet crystals. The majority of the rhodolite crystals are more or less fractured and some have well developed parting planes that divide the crystals into small grains. However, gems of fair size have been obtained from the rock matrix.

In one of the openings a hard ledge of rhodolite garnet gneiss 3 feet thick was encountered. The rock on either side of this ledge was partly decomposed and soft. Garnets of a beautiful pink color were observed in this ledge and of such a size as to indicate the probable presence of gem material. In a thin section cut from a specimen from this ledge much bronzite associated with the garnet was observed under the microscope. The section contained also quartz, biotite, pyrite, apatite, rutile, zircon, and probably ilmenite.

JADE.

BURMA.

The exports of jade (jadeite) from Burma through Rangoon in 1909 amounted to 4,088 hundredweight,[3] valued at £84,450, as compared with 3,211 hundredweight, valued at £73,400, in 1908. The

[1] Hidden, W. C., and Pratt, J. H., Rhodolite, a new variety of garnet: Am. Jour. Sci., 4th ser., vol. 5 1898, p. 294.
[2] Am. Jour. Sci., 4th ser., vol. 6, 1898, pp. 463–468.
[3] Rec. Geol. Survey India, vol. 40, pt. 2, 1910.

production reported from the Myitkyina district, where the jadeite mines are situated, amounted to only 2,487 hundredweight, valued at £14,892—though these figures may not be reliable.

JASPER.

CALIFORNIA.

A red jasper-like quartz with a spherulitic texture, found in the San Francisco region, has been used locally for gems and ornaments. This material is cut by Mr. J. J. Kinrade, of San Francisco, by whom it was discovered about 30 years ago, and who kindly supplied a specimen for examination. Mr. W. T. Schaller, of the United States Geological Survey, generously furnished other specimens, with microscopic sections and general information on the occurrence and nature of the rock. Mr. Schaller states that this spherulitic quartz is found about 1 mile south of Sausalito, in Marin County, and near Lands End station, San Francisco County, about 1 mile northeast of the Cliff House. At the latter locality the spherulitic rock is found in irregular masses in a greatly altered basic rock, probably diabase, which, with sandstone and serpentine, forms a portion of the Franciscan formation.

Near Sausalito the rocks also belong to the Franciscan formation, and consist of sandstone and radiolarian chert with intrusive basalt and diabase which may be portions of the same intrusion. The spherulitic quartz is found at the water's edge where the principal formations are radiolarian chert, basalt, and diabase. A thin layer of sandstone is included between the chert and the igneous rocks at this point. Lenticular inclusions of radiolarian chert and spherulitic quartz, surrounded by layers of, and inclosing, greenish material, occur in the basalt and diabase. Many of these inclusions have been washed out by wave action and deposited as pebbles and cobbles along the shore.

The spherulitic rock occurs with a variety of markings and colorings due to variations in texture and composition. In some specimens the bulk of the rock consists of red spherulites in a matrix of red, brown, and green. In other specimens the matrix predominates and contains spherulites scattered irregularly through it. The spherulites range from almost microscopic dimensions to over an inch in diameter. Most of them measure only a fraction of an inch across. Practically all of the spherulites visible to the naked eye are either dark or light red, but some of the green mineral possesses a spherulitic texture visible under the microscope. The spherulites have a radial structure with concentric bandings around the center. The centers more commonly are bright red and are surrounded by one or more layers of lighter red. The outer portion of the spherulites is less strongly colored and exhibits the fibrous radial texture plainly. Green, brown, gray, and black fragments and streaks compose the remainder of the rock. The whole has been fractured and cemented together again, even the spherulites, many of which show stars, with three to seven or more rays filled with lighter-colored mineral, in their centers. Pebbles and fragments of jasper-like red quartz similar to the spherulite rock, but without such striking texture, are found with the spherulitic rock. They contain similar associated green mineral and country rock. The rock consists largely of silica, but some specimens contain considerable iron present as hematite. An analysis of material from the vicinity of Lands End, by Mr. Schaller, gave 88.5 per cent SiO_2 and 10.3 per cent Fe_2O_3. This rock contains much free hematite filling interspaces between spherulites, besides that occurring as microscopic dust throughout the spherulites and other minerals. Such great quantities of free hematite were not observed in the specimens from near Sausalito, and it is probable that analysis would show a much smaller per cent of Fe_2O_3.

In thin section under the microscope the spherulites present all the appearances of chalcedony but, unlike that mineral, have a positive elongation characteristic of quartz. They are composed of radiated fibers, and between crossed nicols give a dark cross extinction which reacts positively when tested with the gypsum plate. The pigment of the spherulites is seen to be a red dust, apparently hematite, generally arranged in layers with concentric structure. The starlike fractures in the spherulites resemble shrinkage cracks and are filled with fibrous to granular quartz which incloses practically no hematite. The quartz stars are in many cases connected with seams of quartz ramifying through the rock.

In other portions of the rock quartz occurs in irregular-shaped masses, inclosing variable quantities of hematite dust. In places the hematite is segregated into clusters of particles and nearly solid masses in the quartz. Grains of pure hematite over a millimeter across compose a portion of the matrix in some specimens and are especially abundant in the material near Lands End.

The green portion of the spherulitic rock is difficult to determine and is composed of more than one mineral. Much of it is an olive to yellowish green, resembling epidote. Some of the material consists of altered basalt fragments, and other is a nearly amorphous substance with a spherulitic radiated texture locally developed. A part has the texture of chlorastrolite, but has not been identified as that mineral.

The jasper-like spherulitic rock polishes well and is very handsome. The variety of patterns and colors and the extreme beauty of the spherulites when examined closely render the stone attractive. It would serve well for small ornamental objects, as inkstands and paper weights, and some is quite pretty enough for use in jewelry. It could be used in the same way as jasper and strongly colored agates.

Mr. Kinrade reports the occurrence of red spherulitic quartz at numerous places along the coast of California from San Francisco to the Oregon line. A specimen cut from material found near Point Bonita, on Marin peninsula, contains red quartz spherulites in ocher-yellow jasper or quartz matrix. The combination is pleasing.

The trade name "kinradite" has been proposed for the spherulitic quartz by several gentlemen interested in an amateur way in native gems, and in the part Mr. Kinrade has taken to show the possibilities of such material in the San Francisco region. This proposition comes from Harry C. Catlin, John C. Catlin, Thomas R. Craigie, and Alfred Galpin, of San Francisco. The selection of the name "kinradite," in acknowledgement of Mr. Kinrade's services in exploiting a gem of interest to both the local and the tourist trade of California, is very appropriate.

Mr. A. H. Alverson, of San Bernardino, kindly furnished specimens and information concerning a newspaper report on the discovery of bloodstone in Death Valley. Most of the material might be best called red and green jasper, but a few pieces might be called bloodstone. The material came from a locality near Canyon Springs, about 100 miles east of San Bernardino, that has been known for years. The jasper occurs in a vein and in nodular masses. The nodules have red cores and dark green shells and range in size up to 4 or 5 inches in diameter. Specimens examined were about an inch and a half across, and one of them contained a few red patches and streaks in the green. The nodules furnish handsome specimens when polished. No work has been done on the deposit, but years ago considerable surface material was gathered up and sold in San Francisco.

Mr. Young J. Gilbert, of San Bernardino, Cal., mentions the occurrence near Barstow of agate-like jasper, in which are streaks of opal, some being fire opal. Good gem specimens of both minerals have been obtained from the deposit. The property formerly belonged to the California Gem Co., but the assessment work is now kept up by Mr. Gilbert.

MASSACHUSETTS

Mr. Shelley W. Denton, of Wellesley, Mass., reports the finding of a small quantity of red and green jasper in the town of Rowley, Mass. Some of this has been cut "en cabochon" for arts and crafts jewelry with good effect.

LAPIS LAZULI.

CALIFORNIA.

Mr. R. M. Wilke, of Palo Alto, Cal., reports the discovery of lapis lazuli in San Bernardino County, Cal., during 1910. The mineral was found as float and has not been discovered in place as yet, but it is hoped this will be accomplished by further prospecting. Some of the specimens of lapis lazuli were associated with gray limestone, indicating the rock in which the gem may be looked for.

OPAL.

IDAHO.

The occurrence of opal in the northern end of the Owyhee Range, Owyhee County, Idaho, has been briefly described by Lindgren, Drake, and Schrader.[1] Deposits have been opened on Squaw Creek and along the Caldwell-Rockville road about 2 miles east of south of Sommer camp. Some good fire opals have been found, and at one time there was considerable excitement over the gem. Three of the deposits were visited in June, 1910, but no work was in progress at any of them.

The deposit in the valley of Squaw Creek below the junction with Little Squaw Creek is situated in a small rounded hill about 1 mile above the ranch of Jim Keith. The elevation is about 3,500 feet above sea level and that of the mountains around about 1,000 feet higher. The country is treeless and the low hills in the valley are

[1] Silver City folio (No. 104), Geol. Atlas U. S., U. S. Geol. Survey, 1904.

covered only with sagebrush and a small quantity of grass. A few small pits have been made on the summit of the hill and on the south side, cutting into the partially disintegrated basalt in which the opals occur. The basalt is highly vesicular and under the microscope is found to be composed chiefly of lath-shaped crystals of labradorite, augite, and a brownish glass. The basalt is a portion of a flow which partly fills the canyon of Squaw Creek and rests on rhyolite and rhyolite tuff, the most important formation of the region. The partially disintegrated basalt breaks up fairly easily and is removed from the pits in large blocks. These blocks are broken up and the opal picked out. The opal occurs as amygdaloid in the steam holes and cavities in the basalt. The greater part of the cavities contain no opal, and only a part of the opal is of the precious variety, much of it being milky white or colorless. In some of the blocks of basalt broken into the opal is plentiful, and much of it has a fine play of colors. Most of the opal is in small pieces and large specimens of precious opal are rare. Some of the vesicles are filled with chalcedony or chalcedony and opal. Fragments of chalcedony and chalcedony with white opal 2 inches across were observed loose in the soil on the hill. Some of this material is banded both with curved bands and straight onyx bands. Similar specimens of chalcedony and white opal were seen in other places in the valley.

One of the larger opal mines, 3 miles west of Enterprise, contained two sets of workings on different sides of a draw or valley. They are from 35 to 65 feet above the bottom of the draw. The principal workings are on the west side, and consist of several open cuts, the largest about 50 feet long and 25 feet deep, and a tunnel 40 feet long. The other openings are about 150 yards to the northeast diagonally across the draw, and consist of open cuts.

The opal deposits are in whitish chalklike decomposed rhyolite, in which occur inclusions of blocks and rounded masses of gray to brown, glassy, perlitic rhyolite. The perlitic rhyolite appears to be the same as the inclosing decomposed rhyolite, but has not undergone alteration. A weathered yellowish fine porphyry bed occurs over the opal-bearing rhyolite outcropping as a hard stratum. The formations have a gentle northerly dip and the rhyolite can be recognized at numerous places by its light-colored outcrop. The opal occurs in seams and veinlets, filling cracks and joints, as a filling in a brecciated fracture zone, and in nodular masses, both in the altered rhyolite and in the perlite. White and milky opal was plentiful around the dumps and a few small chips of precious opal were seen. Judging from the extent of the work done, it is probable that valuable opal was found.

At another deposit, about 2 miles east of south of Sommer camp and 4 miles west of Enterprise, about half a dozen pits have been made within 200 yards of one another, which range in size from 4 to 20 feet in depth and about the same in width. They are in a bed of partly decomposed whitish rhyolite, interbedded with brownish glassy rhyolite. The formations are gently folded and the rhyolite outcrops at several places to the south along the road on the hill above. The beds have an aggregate north dip. Other prospects were opened on some of the upper outcrops of the rhyolite. Considerable chalcedony and white, milky, and bluish opal were seen on the dumps around the pits. White opal and translucent gray chalcedony are banded together in some specimens like onyx. Very little precious opal was seen around the old workings.

WASHINGTON.

Among localities in Washington where opal has been mined is that on the land of George Odonnell, about 5 miles northwest of Moscow, Idaho. This was known as the Leisure place when worked for opal by Hall & Vennigerholz in 1891 and by Hall & Sons in 1892. The country is rolling meadowland, with but few rock outcrops, well adapted to the growing of wheat, and little attention is paid to the possibilities of gem mining. George F. Kunz [1] states that opal was found at this locality in August, 1890, during the digging of a well. The yield from this locality in 1891 was estimated at over $5,000, and J. G. Vennigerholz states that $5,762 worth were sold.

Mining was carried on at three places situated about 200 yards apart in a triangular space, and Mr. Odonnell's house now stands near the middle. At one of the places, over 100 yards north of the house, nearly an acre of ground had been worked over by pits ranging from a few feet to 20 feet in depth. Southeast of the house a cut 100 feet long and 20 feet wide was made along a branch. Other pits were made southwest of the house. The greatest difference in elevation at the different workings is about 20 feet. The dumps contain piles of vesicular basalt broken into blocks a few inches thick. The basalt is evidently a part of a flow covering large areas in this region. Some of the basalt is partly weathered and has a gray color. The fresh rock is grayish black and hard. The principal minerals determined under the microscope were labradorite feldspar, brown augite, and iron ores with a brownish glass. In places hyaline opal occurs, filling the vesicles and seams in the rock. Occasional patches of precious opal may be found by breaking considerable rock. In places precious opal was found thickly scattered through the basalt. Some very fine gem opal was obtained at this locality.

AUSTRALIA.

New South Wales.—The value of precious opal produced in New South Wales [2] in 1909 amounted to £61,800, as compared with £41,800 in 1908. This was an increase of £20,000, but the production was less than that of 1907 by £17,200. The production of the White Cliffs Division declined from £31,800 in 1908 to £21,800 in 1909 and that of the Walgett Division rose from £10,000 in 1908 to £40,000 in 1909. The beautiful "black opal" from the Walgett Division has realized higher prices than the lighter-colored material. Black opal is, however, scarce.

Queensland.—The production of opal in Queensland,[3] in 1909, was estimated at £2,000, as compared with £2,500 in 1908.

QUARTZ.

PENNSYLVANIA.

Louis J. Deacon, of Atlantic City, N. J., reports the discovery of a limited quantity of quartz crystals 1¼ miles northwest of Stroudsburg, Munroe County, Pa. The crystals were found in a field on

[1] Mineral Resources U. S. for 1892, U. S. Geol. Survey, 1893, p. 776.
[2] Ann. Rept. Dept. Mines New South Wales, 1909, p. 54.
[3] Ann. Rept. Under Secretary of Mines Queensland, 1909.

the Cherry Valley side of Godfreys Ridge. They are mostly clear and colorless and range in size from one-eighth of an inch to 3 or 4 inches in length and from one-eighth of an inch to $1\frac{1}{2}$ inches in diameter. Some are very similar to the quartz crystals from near Little Falls, N. Y., called "Herkimer County diamonds." They occur principally in single crystals, but groups of crystals have been found. No crystals have been found in place. On cutting, several of the quartz crystals proved quite equal to similar stones from other localities.

OREGON.

Prof. G. Montague Butler, of the Colorado School of Mines, reports the collecting of dull-green prase and prase opal by Arthur Rudd, of Joseph, Oreg., on the lower Inmaha River. The material was not placed on the market, but should make a good gem for arts and crafts jewelry.

ROSE QUARTZ.

CALIFORNIA.

Specimens of rose quartz from California were kindly supplied by Messrs. W. D. and George W. Parson. This quartz comes from Tulare County, near the Kern County line, on the east side of the first high western range of the Sierra Nevada Mountains. The specimens range in color from nearly colorless to very delicate pale pink to deep pink. All of the quartz is partly opalescent or milky, though the lighter-colored varieties are nearly clear. The several varieties would serve for gem purposes as beads and cabochon cut stones. Flawless specimens the size of a pecan nut are found, and some pieces of large size with small seams or feathers can be obtained. The more or less perfect fragments up to an inch through are obtained by breaking up larger blocks of the rose quartz, from which they fall out as the fracture or rift planes are exposed.

RUTILATED QUARTZ.

NORTH CAROLINA.

Rutilated quartz has been found on the plantation of David Fortenberry, 2 miles west of Casar, Cleveland County, N. C. The specimens were gathered from the surface of plowed fields. Some of the rutilated quartz is of very good quality, the quartz being clear and colorless and penetrated by abundant small red needles of rutile. Both specimens and gem material have been obtained. The country rock at this locality is biotite gneiss and schist containing porphyritic feldspar crystals and intruded by granite dikes. The occurrence of the rutilated quartz in the rock has not been exposed, as no development work has been done. The cultivation of the land followed by rains serves to unearth and expose the mineral on the surface.

RHODONITE.

CALIFORNIA.

Wheeler rhodonite prospect.—Some beautiful rhodonite has been obtained from a deposit about 9 miles north of Happy Camp, Siskiyou County, Cal. The original work was done for gold by Jack Ince, of

Happy Camp, and consisted of a small pit. The prospect was located in October, 1907, by Cyrus Wheeler and Charles Gilmore. Mr. Gilmore's interest was later taken up by Mrs. E. M. Wheeler. Some of the mineral has been cut by the Southwest Turquoise Co., of Los Angeles. The deposit is on a steep slope on the east side of Thompson Mountain, between the east fork of Indian Creek and Thompson Creek. It is about 4 miles northeast of the forks of Indian Creek or 6 miles in the same direction from the Collier and Smith jade (californite) mine. The elevation is about 4,500 feet above sea level, or 3,500 feet higher than the forks of Indian Creek. A placer claim has also been located on a good spring a quarter of a mile south of the prospect and nearly 400 feet lower. The mountain slopes below the prospect are heavily timbered with spruce and pine, some of which are over 8 feet in diameter. The mountain side at the prospect is covered with tough manzanita brush with a few small scattered trees.

A pit was made above the outcrop of the rhodonite and an open cut below with a tunnel 27 feet long running under it. As exposed by the workings, the rhodonite is in the form of a ledge 6 feet thick, with a northwest strike and dip of about 20° NE. back into the hillside. It was not possible to determine from the limited amount of work whether the rhodonite consisted of a regular bed or whether it was only a lens included in the rock formations. The dip of the ledge should bring it into the tunnel, and its failure there may be accounted for by a fault or pinching out of the deposit. Several small faults were observed in the open cut. It is said at the outcrop that the ledge was small, but became larger within a very few feet.

The country rock in which the rhodonite occurs appears to be a fine-grained quartzite with interbedded black schist. On the hill above is a fine granitoid dioritic rock with soapstone on the summit of the mountain a hundred yards northwest of the rhodonite outcrop. Associated with the rhodonite is considerable black oxide of manganese, both in masses and filling seams and joints through it. Seams of manganese oxide also occur in the quartzite which has a texture similar to the rhodonite and in places has a slight pinkish tint. The material called rhodonite when examined in thin section under the microscope is seen to consist of a mosaic of rhodonite and quartz grains. These facts indicate that the rhodonite may be a replacement of a bed or a portion of a bed of the quartzitelike rock.

The rhodonite used for gem and ornamental purposes has a delicate pale to dark rose-pink color, with an even texture. The pure pink material alone furnishes pretty gems, but probably equally good are those which contain some of the black oxide of manganese and other matrix. Large pieces of pure pink rock are not plentiful, but most of the rhodonite contains greenish-gray inclusions or matrix of altered quartzite. Specimens which contain the three colors often furnish pleasing contrasts for gems. The manganese oxide seams appear as lines and patches in the pink and greenish-gray gems and add to their beauty by the strong contrast. Some rich pink to nearly coral red granular rhodonite is obtained that yields pure gems of several carats weight.

MONTANA.

A specimen of rhodonite from Butte, Mont., was received from the Western Gem Co., of Los Angeles, by which company a quantity of the material has been cut. The specimen consists of granular rhodonite with a delicate rose-pink color, in which are patches of gray quartz, black oxide of manganese, and a few small grains of pyrite. Under the microscope the specimen is seen to consist of elongated rhombic and columnar crystals of rhodonite arranged in radiating groups with quartz, a little pyrite, and dark-brown oxide of manganese stains. Rhodonite from Butte has been used for gems for many years. Such material from the Alice mine, associated with rhodochrosite, was mentioned by George F. Kunz [1] in 1884.

RUBY, SAPPHIRE, AND SPINEL.

INDIA.

The production of ruby, sapphire, and spinel in India in 1909 came from the ruby mines of Mogok, Burma,[2] and amounted to 258,304 carats, valued at £58,649, as compared with 281,014 carats, valued at £83,505, in 1908. The production in 1909 amounted to 205,384 carats of rubies, 13,457 carats of sapphires, and 39,463 carats of spinel. The sapphire deposits of Upper Kashmir, which were worked from 1906 to 1908, were not operated in 1909.

SAPPHIRE.

MONTANA.

Sapphires have been mined at several localities in Montana, both from placer deposits and from the rock matrix. The best known placer deposits are those along Missouri River, east and north of Helena, along Dry Cottonwood Creek, Deerlodge County, and on the waters of Rock Creek, Granite County. Sapphires in rock matrix are mined in the Judith River region, Fergus County. The greater number of the sapphires from this locality have a (sapphire) blue color and are of gem quality, but those from the placer deposits are varicolored and only a small proportion of them can be used for gems. The colors most commonly seen are yellow, yellowish green, bluish green, and greenish blue. Occasionally dark-blue, straw-yellow, topaz-yellow, and light and dark rose-pink stones are found.

Missouri River sapphires.—According to George F. Kunz,[3] the earliest mention of the finding of sapphires in Montana dates back to May 5, 1865, when they were found by a prospector named Ed Collins. Mr. Collins sent specimens to New York and to Amsterdam in search of a market.

Sapphires have been found with gold in the placers along Missouri River from Canyon Ferry, about 15 miles north of east of Helena, for a distance of about 20 miles down the river to a point about 15 miles east of north of Helena. With the exception of a small amount of placer mining at intervals by individuals, no mining has been carried on for several years.

Sapphires were obtained, previous to 1891, as a by-product in gold mining, and no systematic mining for them was attempted, as the demand was limited. Active mining for sapphires commenced in 1891, after a large English company had obtained control of several of the most important deposits. Miles of ditches and flumes were con-

[1] Mineral Resources U. S. for 1883-84, U. S. Geol. Survey, 1885, p. 767.
[2] Rec. Geol. Survey India, vol. 40, pt. 2, 1910.
[3] Mineral Resources U. S. for 1893, U. S. Geol. Survey, 1894, p. 692.

structed and water brought to the deposits for sluicing and hydraulicking. Smaller companies were also formed to mine for sapphires. The English company was reorganized as an American company in 1897, but little work was done after that time. There has been litigation over the properties and valuable flumes and siphons have been allowed to fall to pieces. Much of the property is now owned by A. N. Spratt, of Helena.

A brief visit was made to several of the deposits in June, 1910. No mining was in progress at the time, so that no opportunity was afforded to examine concentrates, and at one mine only was a guide available to point out subjects of interest. J. H. Pratt [1] mentions a number of deposits and shows the approximate location of several of them along Missouri River. George F. Kunz [2] has described some of these deposits and mentioned a number of others. Through the kindness of Mr. A. N. Spratt the writer was enabled to visit the following mines: Eldorado Bar, 9 to 12 miles below Canyon Ferry, and Gruell Bar, 4 miles below Canyon Ferry, on the northeast side of the river, and French Bar, 2 miles below Canyon Ferry, and Spokane Bar, 5 miles below Canyon Ferry, on the southwest side of the river. Among other deposits are Emerald Bar, near Canyon Ferry; Dana Bar, near the mouth of Prickly Pear Creek, across the river from Eldorado Bar; and American Bar, about 6 miles below the mouth of Prickly Pear Creek, on the east side of the river. Among other placers Pratt mentions Magpie Gulch and Cheyenne Bar, near Canyon Ferry, and Metropolitan Bar, across the river from Spokane Bar. Ruby Bar, mentioned by Kunz, is about 6 miles below Eldorado Bar. Pratt states that no sapphires have been found along the river above Emerald Bar, near Canyon Ferry, and that no large quantities have been found below American Bar.

Missouri River flows northwest, with an irregular course in the sapphire region. The elevation of the river is about 3,500 to 3,600 feet above sea level. The flow of water is large and crossings must generally be made by bridge or by ferry. Dams, with electric-power plants, have been erected at Canyon Ferry and below Eldorado Bar. The country along the river in the sapphire region consists of a few bottom lands, terraces, prairies, hills, and mountains. The present period of erosion by the river has not been greatly disturbed at any time, so that no extensive river flats have developed. The terraces, representing former levels of erosion are, in places, over a mile wide and rise with gentle slopes from their edges at the bluffs near the river to the foot of the hills on the farther side. Some of the terraces pass into the prairies, especially between Prickly Pear Creek and Spokane Creek. Draws and small gulches without water cross the terraces at intervals. A few miles from the river the mountains rise to elevations of 5,000 to 7,000 feet above sea level. The country along the river is mostly bare of forest, but pine timber suitable for lumber grows on the mountains to the northeast. The terraces are covered with prairie grass, with a few scattered pine trees growing along the river banks and in the draws. Several creeks entering the river in the sapphire region, as Soup Creek, Trout Creek, and Spokane Creek, are available for mining purposes. Water for hydraulicking might also be pumped from the river to the terraces, and for this purpose

[1] Corundum in the United States: Bull. U. S. Geol. Survey No. 269, 1906, pp. 106–110 and map, Pl. VI.
[2] Mineral Resources U. S. for 1891, U. S. Geol. Survey, pp. 542–544; 1892, pp. 760–762; 1896, pp. 1199–1200.

the presence of several electric power-transmission lines in the country would prove convenient.

The rocks of the sapphire region are chiefly slates, limestones, and quartzites, with syenite or monzonite and other intrusive rocks. The age of the sedimentary formations has not been determined, but it is probable that they are Carboniferous or older. Limestone and quartzite are largely developed in the mountains northeast of the river and are there strongly folded. Dark gray, red, purple, and green slates have been exposed under the majority of the placer workings. A mass of dark-gray coarse-grained syenite or monzonite outcrops at Canyon Ferry, and a similar rock, probably more nearly diorite, outcrops on Trout Creek above York. Kunz[1] says:

> At Ruby Bar the sapphires were observed in a vein of eruptive rock 6 feet wide, cutting green slate. The rock is very much altered, and in it were found, associated with the sapphires, ruby red pyrope garnets and sanidine feldspars. * * * Mr. H. Miers, of the Natural History Museum, London, reports that the rock is a vesicular mica-augite andesite.

Pratt[2] mentions a dike at French Bar 3 to 6 feet wide, that contained greenish sapphires. This dike cut through slate and is probably of the same character as the one described by Kunz.

The sapphire-bearing gravel beds are in the terraces and are called "bars." The principal bars lie at elevations of from 100 feet to nearly 200 feet above the river. At some places there are smaller beds at lower levels and on the slopes from the main bars extending down to the river. The bars that have been most worked for gold and sapphires are over 100 feet above the river. The gravels range in size from a few feet to over 40 feet in thickness in some of the bars and have been washed to depths of 30 feet in places. The gravels are variable in size, and contain sand and pebbles with bowlders over 2 feet thick. The rocks represented are those of the adjoining region with several other types not observed in a brief examination of the region.

Eldorado Bar is about 3 miles long in an east and west direction and from a few hundred yards at the ends to over a mile in width near the middle. The eastern end is near Soup Creek and the western end at the place where the river valley narrows down above the mouth of Prickly Pear Creek. The edge of the bar at the middle near the river is about 150 feet above the water. The bar is from 50 to 100 feet higher at the side along the hills. There is a bench with gravels between the main bar and the river as much as 200 yards wide in places and nearly 75 feet above the water. The main bar contains over 1,000 acres of prairie land, of which only a small part has been mined. Three draws or gulches cross the bar, and mining operations were along these or close to the edge of the terrace. Other prospect pits and shafts were made in testing the gravels. From east to west the three gulches are Tunnel Gulch, Williams Gulch, and Cedar Gulch. They vary from nearly 100 feet deep near the river to a few feet deep back on the bar, and furnish convenient channels for the removal of débris in mining. The gravels have been hydraulicked to depths of more than 20 feet in places. In large areas mined they were 10 to 15 feet thick.

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[1] Mineralog. Mag., vol. 9, 1891, p. 396.
[2] Op. cit., p. 107.

The bedrock exposed in the workings is red, green, and black slate, but a portion of the western end of the deposits may cover limestone and quartzite. These rocks outcrop in the hills on the north and west of the bar in the form of hogbacks. The gravels are composed of much rounded bowlders, cobbles, and pebbles of quartzite, limestone, conglomerate, slate, gabbro, fine-grained trap, granite, and some quartz, chalcedony or agate, etc., with sand. In mining the larger bowlders were left stacked over the placers and all finer débris was washed into the gulches or over the river bank. It is said that a part of the placers were worked for sapphires alone and the gold values sacrificed.

The Houser Lake dam, of the Missouri River Power Co., is about 1½ miles below Eldorado Bar, and will raise the water nearly 50 feet at the bar when completed. This will flood the lower western slope and will bring the water much nearer the placers, so that there will be less elevation for pumping if it should be desirable to obtain a supply of water for hydraulic mining in this way. Another electric power line crosses the bar.

Gruell Bar is about one-third of a mile wide and three-fourths of a mile long, and is said to contain over 160 acres. The edge of the bar is about 150 feet above the river, and the farther side is at least 50 feet higher. Placers were worked along the edge of the bar and about 200 yards farther back. The débris from the mining was washed over the edge of the terrace and into small draws. The gravel beds range in thickness from 3 to 15 feet where washed. The bedrock is chiefly red to purple slate with some sandy slate or quartzite. Bowlders of quartzite, limestone, slate, trap, andesite, gabbro, granite, etc., were observed in the débris piles. Epidote rock, quartz, flint, chalcedony, etc., are also present in the gravels.

Gruell Bar gives place to a large plain on the west, sloping gently to the river. Several prospect pits have been sunk on this flat, and a small amount of placer mining has been done.

The deposits on French Bar have been worked through a distance of over half a mile in an east and west direction and for a width of from 100 to 300 yards. The gravels lie at elevations of from less than 100 feet to about 200 feet above the river. The bar is crossed by several dry gulches that proved of value in mining. The gravel beds washed ranged from a few feet to 25 feet in thickness. The bedrock consists largely of purplish slate, some of which has been epidotized to hornstone. The débris contains bowlders and cobbles of quartzite, slate, limestone, flint, hornblende schist, diorite, monzonite, granite, and porphyries.

Spokane Bar is about 100 feet above the river, and has been worked for a distance of nearly three-fourths of a mile in a north of west and south of east direction, through a width of 50 to 200 yards. The bar passes into prairie country on the south, over which ditches were brought for sluicing and mining.

Montana sapphires were very favorably mentioned by J. Lawrence Smith [1] in 1873. George F. Kunz [2] describes the colors of the sapphires from the Missouri River deposits as varying "from light blue, lavender, light red, light green, to almost bottle green." They are "very dichroic, appearing blue or green when viewed across the

[1] Am. Jour. Sci., 3d ser., vol. 6, 1873, p. 185.

[2] Mineralog. Mag., vol. 9, 1891, p. 396.

prism, but pink or red when viewed along the length of the crystal. They afford very brilliant gems with a remarkable luster; but no true (sapphire) blue or true (ruby) red crystals have been observed from this locality."

Dry Cottonwood Creek sapphires.—Dry Cottonwood Creek heads on the Continental Divide about 12 miles west of north of Butte, and its valley drains west entering Deer Lodge River 11 miles south of Deer Lodge. Sapphires have been found for a distance of several miles along Dry Cottonwood Creek, but the principal developments have been on the upper 4 miles of the South Fork. There are three or more holdings for sapphires along the creek. West Dodd, of Des Moines, Iowa, successor to the Variegated Sapphire Co., has the principal claims on the upper 2 miles of the creek down to the Grand Pre Flat. The Consolidated Gold & Sapphire Mining Co., of Butte, Mont., holds a number of claims extending from the Grand Pre Flat nearly 1¾ miles down the creek. A. D. Hoss, of Deer Lodge, and R. J. Dee, of Silverbow, own claims still lower down the creek.

Gold is associated with the sapphires in all the deposits and forms a large part of the values recovered in mining. The occurrence of sapphires and gold in the gravels of Dry Cottonwood Creek has been known for over 30 years, but mining for them along with gold has been carried on only at intervals. During 1910 a dredge was operated by the consolidated Gold & Sapphire Mining Co., and prospecting with a little placer mining was conducted by West Dodd and by Hoss and Dee. The flow of Dry Cottonwood Creek is small in the upper part, though sufficient for placer and limited hydraulic mining. It would be possible to add to the flow in the upper part of the gulch worked for sapphires by bringing in small flows from other tributaries of the creek. A dredge has been operated to within 2½ miles of the divide at the head of the creek and could have been worked through at least half a mile farther up stream. From the Grand Pre Flat down there is sufficient water for dredging or hydraulicking. Much of the gulch gravel could be sluiced or hydraulicked, as the grade is considerable, but the Grand Pre Flat and possibly one or two others would have to be dredged, as the grade is too slight to wash off the débris.

The valley of Dry Cottonwood Creek is semiwooded. Part of it consists of rounded grass-covered hills and part is covered by a thick stand of pine. The pine is rather small, but could be used in mining operations and much is now being cut for lumber. The forests on some of the hills have been devastated by fire and the dead fallen timber makes a rough country.

The claims of the Consolidated Gold & Sapphire Mining Co. extend from the fall line of the creek at the upper end of the gorge at an elevation of about 6,050 feet above sea level, and about 1¾ miles up the creek to the upper end of the Grand Pre Flat, at an elevation of about 6,175 feet. The gravel beds along the creek range in size from less than 50 feet to over 200 yards in width, and from 3 feet to at least 15 feet in thickness. The thickness of the gravel in parts of the flat has not been determined. The dredge has been started at the lower end of the claims and will be worked upstream. A pond in which to operate the dredge is made by excavating the gravel on the upstream side and piling the tailings on the lower side as a dam.

A bucket dredge with a belt-conveying tailing stacker is used. The sluice and riffles are made of suitable length and grade to catch both the sapphires and the gold in the first washing. The concentrates are further treated with special apparatus. The dredge is operated by steam power, for which cordwood is used as fuel. The rated washing capacity is 3,000 cubic yards in 24 hours, but in practice about 800 cubic yards are washed per day. The dredge was operated one month during 1909 and four months during 1910.

The West Dodd property extends from the upper end of the Grand Pre Flat, with a few breaks where the gravel beds are small, nearly 2 miles up the creek to about the upper limit of water. Sapphires have been found in placer mining to an elevation of 6,800 feet and in a test panning as high as 6,950 feet, the elevation of the highest spring on this fork of the creek. The bottom land gravels on the Dodd property range from a few feet to over 100 feet wide, and the bars in certain places are as much as 100 yards across. The gravels vary from 1 foot to 14 feet in thickness.

The dredge of the Variegated Sapphire Co. was operated on the present Dodd property during the summer of 1907 and one month in 1908. It is reported that the gold recovered paid the cost of operating during a part of the time, but failed to do so in the later runs, and since a satisfactory market for sapphire was not available it was necessary to stop operations. This dredge was of the bucket type and had a capacity of 750 cubic yards in 24 hours. It was operated by a steam engine and had a dynamo for its electric-light equipment. The material from the dredge buckets was washed in a revolving screen, from which everything over 1 inch in diameter was separated and turned into the pond under water at the back of the dredge, while everything under 1 inch in diameter was run over 50 feet of riffles. The débris was piled at the rear of the dredge, forming a dam and pond in which to operate. A square face was cut in the gravels across the gulch. The overburden was first removed for a width of 6 feet upstream and run directly through the dredge without washing. Gold and sapphires were caught in riffles, in which mercury was placed to hold the gold. The concentrates were treated for sapphires later with sieves and special apparatus.

Since 1908 only light prospecting work has been conducted, mining having been temporarily laid aside for the lumber and sawmill industry. At the time of examination (June, 1910) a series of trenches were being made across the gulch about one-fourth of a mile above the old dredge, with a view to determining the shape of the gravel bed, its richness, and the position of the values in both gold and sapphire. The gravel at this place ranged in size from a few inches thick on the side of the gulch to 12 feet and was about 40 feet across. It was composed of cobbles and partially rounded slabs of porphyry ranging up to several inches thick. The values in both gold and sapphire were found on and near bedrock.

The country rock of the sapphire deposits is composed of two principal types, granite and porphyry. The contact between these rocks is at the lower end of the Grand Pre Flat, the granite lying on the west and the porphyry on the east. The granite extends west at least as far as the gorge below the Consolidated Gold & Sapphire Mining Co. property. Porphyry outcrops to the summit of the divide on the east. A typical specimen of the granite, obtained from a copper prospect about one-fourth of a mile below the contact, showed the following minerals under the microscope: Orthoclase, oligoclase, quartz, biotite, hornblende, magnetite, and apatite. It might be appropriately called either hornblende-biotite granite or quartz monzonite.

The porphyry country rock on the upper part of the creek presents slightly varied features, and there may be more than one intrusion of this rock. Much of it is typical granite or quartz-monzonite porphyry with a gray color and variations in texture. A few outcrops of grayish-white quartz porphyry were observed and on the divide dark gray rhyolite was associated with the granite porphyry. In thin section under the microscope, the granite porphyry is found to contain phenocrysts of quartz, orthoclase, oligoclase, and biotite with a little apatite and zircon in a groundmass. The groundmass contains incipient biotite crystals. Some of the phenocrysts are crushed and broken, and in places the fragments are isolated. In some hand specimens fragmental inclusions are observed. The porphyry on a hill locally called Volcano Hill, about three-fourths of a mile north of east of the Grand Pre Flat, is full of vesicular cavities like the blowholes in a lava. It also contains frequent inclusions of other rocks.

A thin section of the quartz porphyry under the microscope showed prominent quartz phenocrysts, with orthoclase and micrographic quartz, a little muscovite and apatite, with a groundmass. The groundmass contains incipient biotite crystals. Quartz porphyry outcropping above the upper placers on the creek contains pinkish-red garnets, some as large as peas.

The source of the sapphires is not known. Unauthenticated reports refer to both the garnetiferous quartz porphyry and to the granite porphyry in the upper part of Dry Cottonwood Creek valley. A careful examination of the quartz-porphyry locality failed to discover any sapphires in place. A tunnel and pits had been made at this place in decomposed porphyry. The material from the openings had slaked to a white crumbling mass. No sapphires were found in panning two buckets full of the slaked porphyry, but only a few garnet fragments and numerous glassy quartz crystals. Many specimens of the granite porphyry from different places along the creek and from the creek gravels were carefully examined for sapphires without success. A more detailed study of the region might discover other types of rock generally considered as a more common home of the sapphire. Prospecting for the sapphire matrix may with reason be carried on to an elevation of 7,000 feet on Dry Cottonwood, but the possibility of other bodies of such rock lower down the creek should not be overlooked.

The sapphires occur in rough crystals, irregular rounded masses, and as waterworn pebbles. The surfaces of many of those which are not much waterworn are strongly etched and corroded. The surfaces of a few of the crystals are curved, as is often observed on diamond. One yellowish-green sapphire crystal weighing a little over 4½ carats had very much the shape of a rough diamond crystal. This effect is due to a rather even development of the basal and rhombohedral faces, producing a form resembling an octohedron. This apparent octohedral form combined with marked curvature of the faces, peculiar etching, and luster due to high refractive index, produces the effect described. The sapphires obtained from the lower part of the creek are more waterworn than those from the upper part. A few red and cinnamon-red garnets, mostly small, are found in the concentrates with the sapphires.

The larger part of the sapphire obtained in mining, either on account of small size or poor color, is best adapted to mechanical uses, and only a small part is suitable in size, color, and quality for cutting as gems. The predominant colors of the Dry Cottonwood sapphires are deep and light aquamarine and pale-yellowish green. Other colors are clear and smoky blue, light and dark topaz yellow, straw yellow, yellowish green like olivine, light and dark pink; some stones are nearly ruby red, pink, lilac, and pale amethystine, and some are colorless. The pleochroism of some of the sapphires is marked, the same crystal appering greenish when viewed across the prism and blue through its length, or pale and deeper pink, as the case may be. It is not unusual to find aquamarine-colored stones with a pink spot in the center. This combination furnishes a pleasing gem when cut. A feature of the deep pink sapphires is their rich and beautiful color under artificial light, even when they are not especially attractive in natural light.

INDIANA.

The occurrence of bronze sapphire in the glacial drift of Morgan County, Ind., was mentioned in this report for 1908 and in connection with diamonds in the report for 1909. The presence of gold in the glacial drifts of this region has been known for a number of years and a small amount of placer mining has been carried on for it. Scales and occasional nuggets of gold are found on the ledges in the stream courses, especially after heavy rains. Some of the natives make a pastime of searching for such gold, gathering the flakes on a knife point and transferring them to a vial. During the prospecting for gold 12 or 15 diamonds have been found associated with corundum, garnet, zircon, etc. The attention of R. L. Royse, of Martinsville, was attracted by the sheen of some of the bronze corundum pebbles and a few specimens have been cut "en cabochon." These stones give a cat's-eye effect when tipped back and forth, and one specimen reflected a strong brownish to reddish movable spot of light. The chatoyancy or sheen is due to minute regularly arranged inclusions in the corundum. Occasionally nearly clear bluish and grayish sapphire pebbles are found.

A deposit was examined on Highland Creek, about 7 miles west of north of Martinsville. In panning, colors of gold were found in many tests in the stream gravels, and a few flakes measured over a millimeter across. The concentrates cantained large quantities of black sands, composed of magnetite, hematite, pyrite or marcasite, titanic iron, with small quantities of corundum, garnet, zircon, etc. Pebbles of the same minerals are also present along with those of the associated rocks. Specimens broken from bowlders in the stream gravels consist of numerous basic rocks, as gabbro, diorite, diabase, and amphibolite, with some of granite, garnetiferous granite gneiss, pegmatite, etc. The country rock in this region is loose shale which has been lightly folded, though in places it is nearly flat. Much of it contains quantities of sulphide concretions, either marcasite or pyrite. The shale may belong to the Mississippian series, which constitutes the lower part of the Carboniferous, and is certainly not older than late Devonian.

AUSTRALIA.

Queensland.—The production of sapphire in Queensland[1] during 1909 is estimated at £23,116, as compared with £15,000 in 1908 and £40,500 in 1907. Early in the year there was a strong demand for large fine stones, followed in the middle of the year by a demand for sapphires for mechanical purposes.

TURQUOISE.

NEVADA.

Otto Taubert turquoise mines.—Turquoise has been mined in two places in Lyon County, Nev., by Otto Taubert. The best of these deposits, which for convenience may be called mine No. 1, is a little over 7 miles N. 75° W. of Yerington, on the west side of the mountain ridge west of Walker River. The mine is situated in a low rounded hill in the rolling country about 1½ miles west of Mason Pass, at an elevation of about 5,350 feet above sea level. The other turqouise deposit, which may be called mine No. 2, is 1½ miles N. 25° W. of Yerington in a small group of hills in Walker River Valley, at an elevation of about 4,500 feet above sea level. An examination of the deposits was facilitated through the kindness of Mr. Taubert and his representative, Mr. E. J. Cooper, of Yerington.

The work at mine No. 1 consists of irregular open work 10 to 15 feet across and 2 to 8 feet deep, and a shaft 40 feet deep about 75 feet north of the open cut. The principal country rock is a bluish-gray and green granular porphyritic rock that may be monzonite or possibly andesite. This rock varies in texture and is partly altered or decomposed. The decomposition is greatest around the turquoise deposit and consists in both kaolinization and a little sericitization of the feldspars. Portions of the altered rock appear to be hardened by the presence of silica or quartz, probably set free during decomposition, and by iron oxides in seams. The badly decomposed rock is light colored to nearly white and does not much resemble the fresher rock. A ledge of green epidotized rock, possibly the same as the country rock, outcrops 75 yards northwest of the turquoise deposit. A vein of pale-green prase-like quartz outcrops on a small knoll 50 yards northwest of the turquoise workings. The greenish color is more prominent in surface material, that a little below the surface having a yellowish-gray color.

The turquoise occurs in seams and joints and occasional nodules in the altered rock. The joints are not especially prominent in any one direction, but are numerous. Many of them are stained by seams of limonite and iron oxide. The seams of turquoise range from mere films to seams one-half an inch thick and are not regular in size or direction. Some specimens of rock contain several branching or intersecting veinlets of turquoise. In color the turquoise ranges from dark sky blue to bluish-green to green. Much of it is very hard and the pure blue variety is slightly translucent and would

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[1] Ann. Rept. Under Secretary of Mines, Queensland, 1909.

yield fine gems. Part of the turquoise, especially the greenish varieties, has patches and dendritic markings of limonite through it, giving a very pretty matrix stone.

A few small lumps of bright blue turquoise were found on the surface of an altered rock outcrop about 100 yards south of the main deposit.

The turquoise at mine No. 2 was found during prospecting for gold. A copper deposit has also been located about 100 yards east of the turquoise openings. Buildings have been erected for convenience in developing the different mineral deposits. The workings in which turquoise has been found consist of two pits about 100 yards east of the office and three shafts near the office. The workings were not in such shape as to allow a detailed examination of the formations encountered. The country rock is decomposed porphyry, probably granite, with a soft altered finer-grained rock, possibly trachyte, occurring as an intrusive. The turquoise occurs in both the altered granitic porphyry and the finer-grained porphyry as seams and nodular segregations. There is considerable soft pale-blue turquoise and some pure blue of a darker shade. Some of the finer-grained rock is stained by limonite, and in this the best turquoise appears to occur. Nuggets of good turquoise are reported to have been found in places in the shafts.

Carr-Lovejoy turquoise claims.—A little turquoise of good color has been found at two places on the Carr-Lovejoy group of variscite claims 9 miles east of north of Blair Junction. Prospecting work was limited at the time of visit, and accordingly only surface material was available for examination. The country rock is dull gray, slaty rhyolite, outcropping in rough rocky ledges. A few small dikes of a trachyte-like rock cut the rhyolite, and the turquoise is associated with these in small veinlets and seams with botryoidal, lumpy surfaces. Some of the turquoise has a very fine blue color and is especially hard. The veinlets exposed ranged up to one-fourth of an inch in thickness and show a tendency to occur as a streak of lenticular or nodular masses.

Rick & Botts turquoise claim.—Turquoise has been found on the Blue Bell turquoise-variscite claim of Carl Rick and W. K. Botts, 4 miles northeast of Coaldale. Turquoise occurs near each end of the claim, which is located on the west side of a rocky canyon. Prospecting was limited to a few pits and surface diggings. The country rock consists of slaty, dark-gray rhyolite and an altered porphyritic rock, probably quartz porphyry. The turquoise occurs in veinlets, seams, and small nodules in the rhyolite, which range up to an inch in thickness. Some of the turquoise is very hard and has a deep sky-blue color rarely excelled by that from any other locality. Specimens of matrix are obtained that have delicate brown cobweb markings and would yield beautiful gems.

Louis Sigmund turquoise claim.—Specimens of turquoise were kindly furnished by Mr. Louis Sigmund, of Mina, Nev., from new deposits discovered by himself about 3½ miles south of Redlich. Three claims have been located and two shafts started with some trench work. Mr. Sigmund states that the turquoise occurs in a porphyry formation with white and brown limonite-stained quartz. The turquoise is found mostly in nuggets and small seams. The specimens examined were fine dark turquoise blue and greenish-blue and they were quite hard.

Dunwoody turquoise claims.—Turquoise of poor quality is found on the Clara and Halley's Comet claims of the Dunwoody-Prichard group of variscite claims 8 miles southwest of Sodaville. It is associated with both fine decomposed porphyry and dark-gray rhyolite; it fills seams and fracture zones with dark greenish-blue to bright-green material, and can with difficulty be distinguished from variscite. It contains copper as a coloring agent, however, and is therefore not variscite. The veinlets range up to three-fourths of an inch thick and some inclose fragments and breccia of rhyolite. The material from the Halley's Comet claim is also green and may be classed as semiturquoise. It could scarcely be distinguished from variscite without blowpipe or chemical tests.

Goldfield region.—Several parties produced turquoise in the Goldfield and adjoining regions during 1910. Some of this turquoise was found and mined during prospecting and mining for gold. Among the producers were Ad. Neher, M. L. Thompson, and George Keller, all of Goldfield. Turquoise was produced at the mines of Mrs. Eva S. Weber, of Belmont, Nev., but the principal work of the owner was in prospecting and mining metals. The Moqui-Aztec mine of S. Simmons, about 12 miles northeast of Sodaville, has been taken up by Jack Lippman, of Los Angeles, Cal., and a limited production of turquoise was reported during 1910. The Montezuma mine of the German-American Turquoise Co. in the same region has been taken up by the Western Gem Co., of Los Angeles. Both of these mines were described in this report for 1909.

VIRGINIA.

The following notes on crystallized turquoise from Virginia, a new occurrence of this mineral, are abstracted from a description by Waldemar T. Schaller to be published in a bulletin of the United States Geological Survey:

A specimen of well-crystallized turquoise from Campbell County, Va., was sent in to this office for identification by Mr. J. H. Watkins. The matrix of the specimen consists of irregular fragments of glassy quartz which are in part cemented together by thin veins of turquoise. On one side of the specimen the turquoise forms a drusy, botryoidal layer, cavernous in texture and including many small irregular fragments of the glassy quartz. The turquoise, with its many included quartz fragments, polishes well and makes a very handsome ornamental stone. The botryoidal coating consists of minute crystals, rhombic in shape but triclinic in symmetry, analogous to the crystals of chalcosiderite, with which turquoise is shown to be isomorphous. The analysis of the mineral, shown below, leads to the formula $CuO.3Al_2O_3.2P_2O_5.9H_2O$

Analysis of turquoise specimen from Campbell County, Va.

P_2O_5	34.13
Al_2O_3	36.50
Fe_2O_3	.21
CuO	9.00
H_2O	20.12
Total	99.96

Other analyses of turquoise yield formulas which are in close agreement with the one given above.

VARISCITE.

Continued new discoveries of variscite are being made in Nevada and Utah, and the location of several new prospects have been reported to the United States Geological Survey since the preparation of this report for 1909. In that report the deposits owned by the Los Angeles Gem Co., northwest of the old mining camp, Columbus, Nev., were described and a number of other newly discovered properties were mentioned. These deposits are described below. The "amatrice" variscite, mined by the Occidental Gem Corporation of Salt Lake City, and the "utahlite" variscite owned by Don Maguire, of Ogden, were described in this report for 1908.

The demand for variscite, especially the matrix varieties, has grown greatly in the last four years, and now large quantities are used in various forms of jewelry. The supply could easily be made greater than the demand, however, if all of the deposits were operated. As it is, this point has been nearly reached, so that only the better grades and odd varieties have found a market. Variscite can be used in many of the same forms of jewelry in which turquoise matrix is used. It will not wear as well as the turquoise, since it is of inferior hardness. The large variations in shades of color of both the variscite and its associated matrix, and the almost innumerable patterns and markings exhibited by them, make possible a wide range of gems adaptable to the tastes of many people. The color of most variscite is not easily susceptible to change, and is less so when the mineral is polished.

In general, there is a marked difference so far in the variscite found in Nevada from that found in Utah. Variscite has been found at four localities in Utah, in Utah, Tooele, Washington, and Boxelder counties. The greater part of the mineral from each of these localities is a brighter green than that from the numerous deposits found in Esmeralda County, Nev. There is also a variation in the colors of the variscite from the different localities of Utah, but the principal differences lie in the matrix and markings. There is more uniformity in color and types of markings in variscite from the several localities in Nevada. The common presence of a black phosphatic matrix with characters similar to variscite in the Nevada material is rare in the Utah gem material and seems to assist in giving the mineral a darker, less vivid green color. However, it is occasionally very difficult to determine from which State a certain stone may have come, and the gems that can be cut from nearly all of the deposits of variscite of either State have some desirable qualities.

NEVADA.

There are many points of similarity in the occurrence of variscite at the different deposits in Esmeralda County, Nev. The whole region is a desert with bare rocky hills on which there is a sparse growth of sagebrush, desert grass, and similar vegetation. Even the higher mountains are practically bare of trees. The lowlands generally consist of borax and salt marshes or dry sand flats. There are few springs, and water for drinking and other purposes has to be hauled to many of the mining camps, sometimes a distance of several miles. The heat is excessive in the summer and the climate is not mild in the winter. When rain does come it may be almost in the form of a deluge. Variscite has been found at elevations ranging from about 4,700 to 6,700 feet above sea level. Some of the deposits are on steep rocky mountain sides and others are on the more gentle slopes. Turquoise has been found within a few yards of variscite in similar forms of occurrence at some of the deposits. In the descriptions given below magnetic readings are used, the variation being nearly 18° east of true north.

The rock with which the variscite is most commonly found is rhyolite. It has also been found in a trachyte-like rock, limestone, jasperoid, and sandy shale. The rhyolite is a dull light-gray to dark-gray and black chertlike rock. It is mottled in places and shows flow banding. In some outcrops the rhyolite resembles a sedimentary rock and is with difficulty distinguished from hard siliceous phases of the limestone and shales called "jasperoid" by S. H. Ball[1] in the country farther south. The rhyolite generally makes a rough country, outcropping in irregular masses and ledges with angular surfaces, and on breaking down covers the hills and slopes with sharp flaky fragments. The formations have been considerably folded near some of the deposits, and the consequent curving outcropping ledges of hard rhyolite can be seen across the country. Faulting and jointing has been extensive, also, and some of the fault zones are marked by much breccia. Small fault planes and joints have served as channels for the passage of solutions and the deposition of such minerals as variscite.

The limestone present around some of the variscite deposits is dark-gray to nearly black and contains many cherty and siliceous phases. The cherty portions, or jasperoid, outcrop in rough ledges and masses similar to the rhyolite. The occurrence of variscite in sandy shale is limited and was observed at the mines of the Los Angeles Gem Co. The trachyte-like rock has been observed at several of the deposits associated with variscite and is so badly altered that its true nature could not be definitely determined. It is generally present in dikes of small size to several feet across. Other formations occur in the region, but variscite has not been found associated with them. Some of these are sandstone, quartzite, quartz porphyry, somewhat altered, vesicular basalt, serpentine, etc.

The variscite occurs as a filling in fissures and joints, replacing other minerals, and as irregular and nodular segregations. The variscite not only fills many seams and joints in the rocks, but the crevices between shattered and brecciated fragments of rocks along the fissures. Thus brecciated zones more than a foot 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 individual seams of variscite vary from paper thickness to 2 or 3 inches in width. Locally they may bulge out into nodular masses several inches across. The variscite-bearing streaks and breccia zones may attain a thickness of over 4 feet, but even these are not rich in variscite for a distance of many yards. The different deposits in the same region have no connection with one another, but appear to be of local origin.

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[1] A geological reconnaissance in southwestern Nevada and eastern California: Bull. U. S. Geol. Survey No. 308, 1907, p. 77.

Candelaria variscite prospect.—Probably the first occurrence of variscite recognized in Nevada was that near the summit and on the opposite side of the mountain south of Candelaria. The deposit is close to the old workings of the Norton Bell silver mine, on the summit of the mountain, nearly a mile south of Candelaria and about a mile west of the Mount Diablo silver mine. The variscite prospect is in the eastern part of the Candelaria Mountains, at an elevation of about 6,525 feet above sea level, and the summit of the mountain near by is about 25 feet higher. The best mineral appears to have been found on the eastern brow of the hill, but other prospects have been opened on the steep slope below. At the time of examination (May, 1910) the name of George W. Brown was posted on the location monument, but the property is claimed by Edward Tilden, of Goldfield, by whom a production of variscite was reported in 1910.

The work consisted of an open cut with an incline shaft from its bottom and a prospect pit in a direction of N. 60° E. along the hillside. The country rock is principally dull-gray altered rhyolite that on casual inspection resembles limestone or limy slate. In places the rhyolite has a marked banding with occasional streaks of dark glass inclosing spherulites. The rhyolite has a strike of N. 60° E. and a dip of 45° NW. It is cut by a dike of altered trachyte-like rock at the variscite deposit. Both rocks have been fractured and some of the joints filled in with minerals. The summit of the mountain, a short distance to the northwest, is capped by vesicular basalt. The core of the mountain is probably serpentine, for a mass of this rock outcrops in the walls of Pick Handle Gulch to the northeast.

The variscite occurs along the contact of the rhyolite and trachyte in seams, veins, and occasional irregular masses and nodules in both rocks. The veins and seams fill joints and crevices, cutting the rock at all angles. Some of them split and branch out into two or more prongs. Some of the veins extend into breccia zones in which many angular fragments of rock, either the rhyolite or trachyte, are inclosed in variscite. The seams and veins of variscite range from paper thickness to half an inch in thickness. Most of the veinlets are less than one-fourth of an inch thick. The color of the variscite ranges from pale green to deep emerald green, which is partly translucent. Much of the variscite has an even pure color, but some of the thicker veinlets and masses are a little mottled with dark and light green, or are pale green in the interior, grading into dark emerald green on the borders. The variscite is close grained and compact, and ought to give good results as a matrix stone if polished along with a portion of the dark gray rhyolite or white to gray trachyte with which it is associated. Very few pure green stones of large size could be cut from the product of the Candelaria variscite prospect.

Coaldale region.—A group of variscite claims has been located 4 miles northeast of Coaldale, Esmeralda County, Nev., by G. E. Wilson, Abner Capps, Carl Riek, and W. K. Botts. These claims are in the rough country on the south side of the Monte Cristo Range, at elevations ranging from 6,150 to 6,700 feet above sea level. They extend through a distance of about three-fourths of a mile along a rocky canyon. Two adjacent claims, the Morning Glory and the St. Patrick, owned by G. E. Wilson, lie principally on the hill on the southeast side of the canyon. Two others, the Bonnie Blue Bell and the Blue Bird, owned by Wilson & Capps, extend east and west across the canyon and overlap the Morning Glory and St. Patrick claims. The Blue Bell claim, owned by Riek & Botts, is on the northwest side of the canyon, along the top and side of the steep ridge forming the wall of the canyon. Both variscite and turquoise have been found on this claim. There is a spring a short distance northeast of the St. Patrick claim. At the time of examination (May, 1910) but little more than assessment work had been done on the claims. This consisted of open prospect pits and trenches and blastings in harder rock outcrops. On the Morning Glory claim a sloping pit 2 to 8 feet deep, 10 feet wide, and 35 feet long was made in the hillside. On the other claims smaller prospects had been opened and a few blasts put in the prospects that looked favorable.

The country rock is chertlike, gray to black rhyolite, which outcrops in hard rugged ledges along the canyon cutting the group of claims. There are a few small dikes of altered trachyte-like rock and some outcrops of large bodies of decomposed quartz porphyry in the vicinity. The quartz porphyry beds are as much as 200 feet thick in places, and one prominent bed outcrops along the west side of the canyon along the east line of the Blue Bell claim. The formations are folded and in places are very much contorted. The strike is in general to the north and the dip is variable.

On the Morning Glory claim a streak of variscite and matrix ranging from 1 to 4 feet thick was exposed in the open cut. The streak pinched down and bulged out quite irregularly and in places consisted entirely of phosphatic mineral, in part variscite and in part black mineral. The streak also contained rock breccia with variscite filling. A few veinlets of variscite could be traced from the end of the open cut northward up hill for a number of feet, and other veinlets outcropped in this line for a number of yards to the hilltop. The veinlets ranged from one-sixteenth to three-fourths of an inch in thickness. Some of the variscite from the open cut was finely marked with turtleback and other odd mottlings and occurred in large nodular pieces several inches across. The turtleback marking, composed of rounded patches of pale green variscite with a black matrix filling between them, would make a very fine matrix gem. The color of some of the other variscite from the main deposit and from the veinlets on this claim is dark green, and a black flinty brecciated matrix filled with this forms a beautiful contrast. Seams of variscite have been found at several places on the St. Patrick claim. Some of it has a good green color, and some has a black mottling.

Variscite has been found in seams, veinlets, and nodular masses on the Bonnie Blue Bell and the Blue Bird claims. The best deposits have been found on the east side of the canyon and are rather plentiful on the steep hillside. Some of the veinlets consist of streaks of nodular masses of variscite. Variscite of a deep green color and some mottled black matrix are found on these claims.

Variscite is found near the middle of the Blue Bell claim in small veinlets, seams, and nodules and loose in the surface débris. The variscite has a good color, and the mottled black and green markings of some pieces are pleasing, but large veinlets or nodules are scarce. Turquoise is found at each end of this claim and is described under that mineral.

Another variscite claim has been located by Wilson and Capps on the west slope of the Monte Cristo range, about 3 miles east of north of Coaldale. The claim has an east and west extension on the steep rocky mountain side. A small gulch crosses its lower end. This deposit is about 2½ miles west of the claims just described. The rock is the same rough, cherty gray rhyolite containing a few decomposed porphyry streaks. The variscite occurs in veinlets and fills brecciated streaks of rock. Much yellowish-green variscite was found on the upper part of the claim and some with an emerald green in a small rocky gulch on the lower part.

Mr. Louis Sigmund, of Mina, Nev., kindly furnished specimens of variscite from a claim he has located about 6 miles northeast of Coaldale, or about 1½ miles northwest of the claims of Wilson, Capps, and Rick. The specimens consist of veinlets in cherty rhyolite, sheets with botryoidal surfaces from veinlets, and nodular variscite in black matrix. The specimens of the veinlets and botryoidal variscite have a good green color and some is finely marked with black. The nodule is a light green and has a turtleback mottling.

Another variscite claim has been located by M. M. Holland, about 5 miles northeast of Coaldale, and a small production of gem was reported in 1910.

Blair Junction region.—Nine claims for variscite and turquoise have been located by Clyde Carr and Mrs. Mattie Lovejoy in the Monte Cristo range, about 9 to 11 miles east of north of Blair Junction. These claims lie at elevations ranging from 6,200 to 6,600 feet above sea level along the northeast side and top of a ridge. The country is broken by numerous rocky draws and gulches from 50 to 200 feet deep, heading along the ridge. The claims are grouped end to end in two adjoining rows with a northwest-southeast trend. There are five claims in the northeast row named Mars, Wren, Comet, Azure, and Green Fly from southeast to northwest, and four claims in the southwest row named Lulu, Long Chance, Jupiter, and Progress. There is a spring near the Progress claim. The variscite of this region was discovered by Mrs. Lovejoy in January, 1910. Locations were made in partnership with Mr. Carr, as new prospects were discovered. The quantity of work done on some of the claims is in excess of that required for the assessment. The openings consist of cuts, pits, and shallow shafts.

The country rock is principally dull gray to black chertlike rhyolite, the harder beds of which outcrop as rough, rocky ledges. The rhyolite is cut by small dikes of altered quartz porphyry or trachyte, and in places by larger masses of such rock. One of the porphyry masses near the northwest end of the claim was about 100 feet thick. Limestone and jasperoid outcrop in the region adjoining the variscite deposits. The bedding of the rhyolite strikes about northwest with a variable southwest dip. The rocks have been folded and in places are broken by fault zones filled with breccia. The variscite occurs in nodular masses, seams, and veinlets, principally in the rhyolite. The greater part of the gem material comes from cross veinlets striking about northeast with nearly vertical dips, but some good colored variscite is found in seams cutting the formations in other directions. The veinlets with a northeast trend are the thickest and are more continuous in length than the others. Good variscite matrix is also obtained from breccia zones and from nodular segregations in them and in other veins cutting the rock.

Several prospects have been located on the Comet claim and variscite has been found in both veinlets and nodular segregations. Some of the variscite in the seams has a good dark-green color. Masses of nodular material are found composed of round balls of pale grayish-green variscite with black rims around them in grayish and yellowish-colored matrix. The whole is compact and has a fairly even grain, so that it ought to polish well and would yield an attractive unique gem. Considerable of this material was found loose on the ground at one place. On the Azure claim a streak of black matrix with variscite 6 to 20 inches thick was opened in a cut. Part of the variscite in this black matrix has a fine green to bluish-green color. and some occurs as rounded masses in the black, yielding a beautiful mottled matrix. In places nodules of pure dark-green variscite an inch across are found in the black matrix. On another part of the Azure claim nodules of variscite were found along a small altered trachyte dike. This material was largely pale yellowish green, and not of gem grade. In another place several veinlets of variscite were found in an open cut.

Variscite is exposed in an open cut and in the rock outcropping in the hill above it, near the northwest end of the Mars claim. Some of the veinlets are as much as an inch thick and can be traced a number of feet in a northeast direction.

Variscite has been found at several places on the northwestern half of the Wren claim, and part has not been worked below the outcrop, while part has been opened by prospects. In one of the cuts three large veinlets ranging up to 3 inches thick were exposed, one of which can be traced nearly 100 feet on the outcrop from the cut. Some of the variscite occurs in nodules with mottled black matrix markings. A seam of translucent dark-green variscite, resembling chrysoprase in color, up to half an inch thick, has been found on this claim. It has botryoidal surfaces in places and is very hard. In another cut several veinlets of variscite with brecciated and nodular variscite were found. This variscite ranges from pale green to dark green and part is mottled and speckled with black matrix. Outcrops of other veinlets of variscite with apple green and light to dark green shades have been found on the Wren claim.

The work on the Green Fly claim to the northwest was not so extensive as on the others, as the outcroppings were not so promising. On the Progress claim nodules of pale bluish-green variscite giving coarse turtleback markings were found loose on the surface. These nodules range in size from one-half inch to 2 inches in diameter and would yield odd-looking gems. At one place, on the Jupiter claim, a prominent veinlet of light grayish-green variscite was found projecting above the inclosing rock an inch or two. In a pit at another place seams of yellowish-green and green variscite and yellow phosphatic nodules were found. The phosphatic nodules range in size up to 2 inches in diameter and some would give turtleback effects if cut. On the Long Chance and the Lulu claims several small seams of variscite and a little float material have been found. On the

Lulu claim turquoise of good color has been found, and is described under that mineral.

Sodaville region.—A group of variscite claims has been located about 8 miles southwest of Sodaville by Mrs. Clara Dunwoody, C. M. Dunwoody, and C. Prichard. These claims are in the rough, broken country at the east end of the Excelsior Mountains. The elevation of the lowest point on the claims is about 5,300 feet above sea level, and that of the highest point about 6,300 feet. There are six claims along and on the sides of and at the head of a rocky gulch or canyon from 300 to 600 feet deep. The gulch has a southeast course and debouches on a long slope extending down to the valley of the Rhodes salt marsh. The names of the claims are the Variscite No. 1, Variscite No. 2, King Solomon, Clara, Blue Bird, and Halley's Comet. Numerous prospect pits have been made on the claims, with a cut 25 feet long, 5 feet wide, and 2 to 10 feet deep on the Variscite No. 1 claim.

The country rock is chertlike gray to black rhyolite, which has harder, more resistant siliceous beds. These beds outcrop as rough ledges 10 to 20 feet thick, across the country. The rhyolite is cut by dikes of altered light-colored porphyry or trachyte, both parallel with and across the bedding. The formations have been considerably folded and across the canyon south of the variscite deposits a large synclinal fold can be plainly seen by the curved outcrops of the hard siliceous rhyolite ledges. The variscite occurs principally in seams, but some nodular masses are found. The variscite is associated with the rhyolite and occurs in seams and nodules in the altered porphyry. Greenish-colored turquoise also occurs in the altered porphyry.

On the Variscite No. 1 claim a veinlet of variscite was found filling a prominent joint that could be traced for about 100 feet in a direction N. 60° W. This veinlet stood about vertical as exposed in the open cut. Another parallel seam, but less continuous, and several short veinlets crossing the main one were found. The variscite varies from light to dark green. On the Variscite No. 2 claim two veinlets of variscite one-sixteenth to three-fourths of an inch in thickness were exposed in an open cut 15 feet long and 5 feet deep.

Good variscite has not been found on the King Solomon claim. A soft bluish-white mineral occurs in altered porphyry in seams and nodules like turquoise or variscite. It has a hardness of about 2.5 when dry and resembles halloysite or a similar variety of clay-like mineral. Both variscite and turquoise are found on the Clara claim and the turquoise is mentioned under that mineral. Some of the variscite has a fine green color and occurs in veinlets up to 2 inches thick and in breccia zones 5 inches thick. Fine specimens of variscite inclosing black matrix breccia have been found on this claim. Variscite has been found at several places on the Blue Bird and Halley's Comet claims, and semiturquoise on the latter claim. The variscite occurs principally in veinlets and seams, but there is nodular material. Part of it is of good quality and is dark green.

UTAH.

The variscite deposits 5 miles northwest of Lucin, Utah, were first opened by C. J. Burke in 1902, by a shaft 22 feet deep, in search for gold. The claims were abandoned, however, since no gold was found.

The variscite was rediscovered by Frank Edison in 1905, but was not taken up until August 3, 1909, at which time the present claims were located. The locators and owners are Frank Edison and Edward Bird. Mr. Bird is the discoverer of the variscite deposit in Tooele County, Utah, from which "amatrice" is obtained.

The deposits are in the northern part of an irregularly shaped hill, called Utahlite Hill. Utahlite Hill is about 1 mile long in a northwest-southeast direction and about one-half mile wide. It has an elevation of about 5,000 feet above sea level and rises over 300 feet above the mesas and gentle slopes at its base, and about 500 feet above the railroad at Lucin. The variscite deposits are in the higher parts of the hill.

Four claims have been located and these are, in order from northwest to southeast, Utah Gem, Greenback Lode, Utahlite, and Protection Lode. These claims adjoin one another with their longer directions parallel. The best showing for gem material is on the Utahlite and the Utah Gem claims. On each claim the mineral is in and around small rocky summits standing above the rest of the hill. These summits have cavities and small caverns around the sides of the rocks resembling those made by wave action. They were probably formed on one of the shore lines of the former Lake Bonneville. The work done at the time of examination consisted of an open cut 50 feet long and 2 to 5 feet deep, with several prospect pits.

The rock in which the variscite occurs and which forms the crest of the hill is cherty or chalcedonic quartz, which contains inclusions of nodules and streaks of limestone. The limestone inclusions range up to a foot thick and in places are several feet long. The character of most of the rock is that of a hard breccia cemented together by silica. This breccia forms rough rocky ledges and knobs rising from a few feet to 25 feet above the hill slopes. The bedding of the limestone-bearing chert is about northwest, with a dip to the northeast. Many joints cut the rock with a similar strike, but southwest dip. The surfaces of the hill below these outcrops are covered with detritus and loose rock, so that the formations at a lower level do not outcrop near the variscite deposits. Three of these knobs contain large quantities of variscite.

The variscite occurs in balls, nodules, and irregular masses in the chert. Veins of variscite are not common, but some with a northeast strike and northwest dip were seen on the Utah Gem claim. The nodules and balls of variscite range in size from a fraction of an inch to several inches across and some of the segregations of variscite inclosing matrix are a foot across. The variscite fills fractured and brecciated zones in the rock, some of which it replaces, and it incloses other parts. The replacements are generally rounded, concretionary masses often with banded concentric structure. The fragments of some of the brecciated rock, especially white quartz, that have been inclosed by and cemented with variscite have remained angular and sharp. Some of the concretionary forms appear to grade from green variscite cores into the inclosing yellow, brown, gray, and white phosphatic and cherty minerals. There is considerable chalky mineral filling cavities in the variscite-bearing rock and coating the nodules and masses of variscite. A quantity of variscite pebbles and cobbles has been found in the cut in the loose detritus below the main outcrop on the Utahlite claim. These probably owe a large part of their rounded form to the nodular shape of the variscite in the original rock, but have also probably been rounded by water action on a former lake shore. The pebbles are coated with a white chalky substance, and have to be broken into before the presence or quality of the variscite can be determined.

The matrix with which the variscite is associated is chiefly silica, either chert, chalcedony, or quartz. Some other phosphatic minerals, in part probably allied to variscite, are often present. Both the variscite and the matrix minerals possess various shades of color, several of which are sometimes present in a single specimen. The different colors combined with the various markings and patterns due to the structure of the mineral and the brecciation of the matrix furnish a large range in the types of stones that can be cut from the variscite. The variscite ranges in color from very pale green through different shades of green to bright grass green. The matrix varies from white to gray, to yellow, to brown, and nearly to black.

The gems that can be cut from the variscite from the Edison and Bird mine range from large pure stones with light to dark green color through those with small quantities of matrix to those in which the matrix predominates. The dark and bright green variscite is obtained in pieces that will cut into pure stones measuring more than an inch across, and paler-colored mineral will yield even larger pure stones. Some of the bright-green variscite is partly translucent, and thin pieces and small pebbles display their color well in the partially transmitted light. This is especially true of the coarser-grained, finely crystalline variscite. Specimens of matrix are obtained that will yield slabs 6 inches across, some of which show quite remarkable patterns and colors. One block of matrix found at this mine measures 4 to 6 inches in diameter and weighs several pounds. The whole mass is composed of variscite mottled with brown and white matrix. The pattern is the typical turtle-back and the markings are coarser in some parts of the specimen than in others. The markings are due to rounded patches or nodules of pale to bright green variscite, some of which are surrounded by rims of white or gray and all filled in with purplish brown matrix. The brown matrix occurs only as an internodular filling and the seams are rarely over a millimeter thick. Occasional larger patches of matrix occur where several seams meet around the variscite nodules. The rounded masses of variscite vary from a fraction of a millimeter to a centimeter in diameter. Other smaller pieces of mottled variscite have been found along with specimens of brown, gray, and white matrix, with practically the same texture. Some pieces of mottled matrix contain little, if any, green variscite, but would cut into stones with the turtle-back markings.

Among other types of variscite matrix is that with bright grass-green variscite mottled with patches and cloudlike masses of lighter green material, or vice versa. Such matrix may contain seams and spots of white, gray, or yellowish mineral through it. A white quartz breccia cemented and filled in with bright green variscite is also a pleasing stone when cut, but is more difficult to polish because of the difference in hardness of the two minerals. The quartz occurs in sharp angular fragments, which are in excess of the variscite in some specimens but generally less prominent.

The variscite and variscite matrix from this locality would yield very beautiful gems for the so-called barbaric jewelry. It is susceptible to nearly every form of cutting used with opaque gems, but on account of its comparative softness is not adapted to rough wear. For necklaces, pendants, brooches, pins, belt stones, etc., it is well suited. The especially bright colors of some of the variscite from this locality are rarely found in that from other places, and the variety of markings shown by the matrix is probably equal to any other material found. The brightest green occurs in masses of granular variscite, the coarse varieties of which are not sufficiently compact to cut for gems. The granular variscite has been investigated by Waldemar T. Schaller, who has prepared the following abstract from his description to be given in a bulletin of the United States Geological Survey:

Another phase of the mineral is where it exists as a granular aggregate of well-formed rectangular crystals, the largest of which are about a millimeter long. The crystals are orthorhombic in symmetry and similar in the values of their crystal angles to those of scorodite and strengite. The variscite crystals are vivid green in color, but when heated before the blowpipe the green color changes to a deep lavender. This change of color will also take place at as low a temperature as 160° C., at which temperature all of the water of the mineral is given off. Together with these changes the optical properties are likewise profoundly affected, the refractive indices and the double refraction becoming much less. It was found that a small amount of chromium and vanadium is present in the mineral, and chemical analyses gave the following values:

H_2O	22.68
P_2O_5	44.73
V_2O_3	0.32
Cr_2O_3	0.18
Fe_2O_3	0.06
Al_2O_3	32.40
Total	100.37

The ratios calculated herefrom are $4H_2O.1P_2O_5.1Al_2O_3$, the analysis confirming the formula $AlPO_4.2H_2O$, already established for the mineral.

MISCELLANEOUS.

COPPER ORE GEMS.

ARIZONA.

Mr. John F. Gross, of Chloride, Ariz., kindly supplied specimens of copper-stained rock from about 24 miles northwest of Chloride. Some of it has been cut with good results. The color is the usual blue of many copper salts, mottled with patches and tufts of green and occasionally of red, brown, and white. Some of the rock is fine-grained, altered quartz porphyry which has been heavily stained with copper and hardened by silica or chalcedony. The green spots are tufts of malachite and the red is due to small quantities of hematite. The rock is compact and fairly hard, so that it should receive a good polish. Another specimen examined consists chiefly of fractured glassy quartz, with the blue copper stains and patches of malachite throughout.

BEACH PEBBLES.

CALIFORNIA.

Specimens of beach pebbles found on the southeast end of Santa Catalina Island were kindly furnished by the Catalina Novelty Co., of Avalon. This material has been cut under the name first of "Catalina sardonyx" and then "catalinite." It consists of mottled green, gray, white, yellow, brown, and red minerals which have not been given sufficient study for identification. All are sufficiently hard and compact to receive a good polish. The gems cut from this material are very odd and pretty.

PRODUCTION.

There was a decrease in the quantity of the production of precious stones during 1910, and this was accompanied by a large decrease in value. The large decrease in the output of a few of the more important gem minerals—as tourmaline, turquoise, chrysoprase, etc.—readily accounted for the fall of the value of the production from $534,380 recorded in 1909 to $295,797 in 1910. There were changes, both increases and decreases, in the production of other gem minerals, but their effect on the total figures was small compared with that of the minerals mentioned above.

Attention is called to the fact that in a number of cases it has been necessary to estimate the value of the production of certain minerals, in part or wholly, from the quantity of the output. In doing so the values given are as nearly as possible those that a miner would receive in selling rough gem minerals to the dealers. It should be understood that after changing hands and the application of labor on the minerals the value increases more than proportionately to the cost of the labor. The value of the elaborated gems obtained from the output of rough gem material in the United States is several times more than that given in the table of production. The table therefore serves as a basis of estimation and is not to be taken as an accurate statement of the value of the output. It is not possible to obtain statements of the output of all varieties of gem minerals each year, as such minerals originate from new sources and pass through the hands of different dealers, all of whose names are not on the Survey lists, or of people who do not cooperate in the work of collecting such statistics. Dealers who learn of new sources of supply or purchase gem minerals from intermittent producers will greatly help in the preparation of these reports by supplying information on such subjects.

Production of precious stones in the United States in 1907, 1908, 1909, and 1910.

	Value.				Remarks.
	1907	1908	1909	1910	
Agates, chalcedony, etc., moonstones, etc., onyx.	$650	$1,125	$750	$2,268	About 1,150 pounds; California, Colorado, Montana, and Wyoming.
Amethyst	850	210	190	....	No production reported.
Azurmalachite, malachite, etc.	250	5,450	2,000	550	475 pounds; Arizona and Nevada.
Benitoite	1,500	3,638	500	....	No production reported.
Beryl, aquamarine, blue, pink, etc.	6,435	7,485	1,660	5,545	About 30 pounds rough and selected.
Californite	a 25,000	....	a 18,000	a 8,000	1,500 pounds; California; not sold.
Catlinite	25	....	....	....	No production reported.
Chiastolite	20	....	....	....	Do.
Chlorastrolite	....	25	2,400	a 2,000	1,250 pounds; Michigan.
Chrysocolla	150	600	300	....	No production reported.
Chrysoprase	a 46,500	a 48,225	a 84,800	a 9,000	1,700 pounds; California.
Cyanite	100	....	....	....	No production reported.
Diamond	a 2,800	a 2,100	2,033	a 1,400	208 stones; Arkansas and California.
Diopside	....	120	....	....	No production reported.
Emerald	a 1,320	....	a 300	a 700	North Carolina.
Epidote	60	....	15	....	No production reported.
Feldspar, sunstone, amazon stone, etc.	1,110	2,850	a 2,700	2,510	4,128 pounds; Colorado and California.
Garnet, hyacinth, pyrope, almandine, rhodolite.	6,460	13,100	1,650	3,100	151 pounds; California, Arizona, and Colorado.
Gold quartz	1,000	1,010	....	1,000	Colorado and California.
Jasper	675	....	100	475	500 pounds; Colorado and California.
Opal	180	50	200	270	Nevada.
Peridot	1,300	1,300	300	....	No production reported.
Petrified wood	325	....	....	....	Do.
Phenacite	25	95	50	50	Colorado.
Prase	....	....	....	100	50 pounds; Oregon.
Pyrite	400	....	....	....	No production reported.
Quartz, rock crystal, smoky quartz, rutilated, etc.	2,580	3,595	2,689	1,335	1,753 pounds; Colorado, Maine, Vermont, California, and Texas.
Rose quartz	6,375	568	2,970	2,537	25,025 pounds; South Dakota and California.
Rhodocrosite	150	....	....	....	No production reported.
Rhodonite	....	1,250	125	a 6,200	3,200 pounds; Montana and California.
Ruby	2,000	....	....	....	No production reported.
Rutile	200	....	25	....	Do.
Sapphire	a 229,800	a 58,397	a 44,998	52,983	1,062,000 carats; Montana and Indiana.
Smithsonite	800	a 1,200	300	....	No production reported.
Spodumene, kunzite, hiddenite.	14,500	a 6,000	15,150	33,000	120 pounds; California.
Thompsonite	....	35	100	610	About 50 pounds; Michigan, Minnesota, and New Jersey.
Topaz	2,300	4,435	512	884	75 pounds; California, Colorado, and Texas.
Tourmaline	a 84,120	a 90,000	a 133,192	a 46,500	1,548 pounds; California and Maine.
Turquoise and matrix	23,840	a 147,950	a 179,273	a 85,900	16,886 pounds; Nevada, New Mexico, Arizona, and Colorado.
Variscite, amatrice, utahlite	7,500	14,250	35,938	a 26,125	5,377 pounds; Utah and Nevada.
Miscellaneous gems	....	....	1,060	2,755	Datolite, obsidian, fossil coral, and ornamental stones with trade names.
Total	471,300	415,063	534,380	295,797	

a Estimated or partly so.

IMPORTS.

The importation of precious stones into the United States in 1910, as reported by the Bureau of Statistics, showed a slight increase over that of 1909. The principal increases were in the imports of pearls, rough or uncut diamonds, and diamonds and other stones not set. There was a decrease in the imports of cut diamonds. The importation of rough diamonds has not yet returned to the high level preceding 1907.

The following table shows the value of the diamonds and other precious stones imported into the United States from 1906 to 1910, inclusive:

Diamonds and other precious stones imported and entered for consumption in the United States, 1906–1910.

Year.	Diamonds.					Diamonds and other stones not set.	Pearls.	Total.
	Glaziers.	Dust or bort.	Rough or uncut.	Set.	Unset.			
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
1910	213,701	54,701	9,212,378	......	25,593,641	4,003,976	1,626,083	40,704,487

[a] Including agates. Agates in 1906, $20,130; in 1907, $22,644.

GRAPHITE.

By Edson S. Bastin.

INTRODUCTION.

The physical and chemical properties, origin, and uses of natural graphite and the method of manufacture of artificial graphite were discussed by the writer in the report on graphite for 1909. That report also contains a bibliography (with brief abstracts) of the more important general treatises on graphite and of publications descriptive of occurrences in the United States. This report may be obtained free by addressing the Director of the Geological Survey at Washington, D. C. The general sections on character, uses, etc., and the bibliography will be republished with corrections and additions every other year.

PRODUCTION AND IMPORTS.

NATURAL GRAPHITE.

Production.—The bulk of the production of crystalline graphite came in 1910 from Alabama, New York, and Pennsylvania, with a small quantity from Alaska. 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 in Colorado, Michigan, Nevada, and Wisconsin. The total production of amorphous graphite in 1910 was notably larger than in 1909, mainly because of largely increased production in Georgia, where there was not only greater output from established industries, but where one new producer started in business. Owing to decreased output in both Pennsylvania and Alabama, the total production of crystalline graphite in 1910 was somewhat less than in 1909. As usual, New York ranked first because of the large production of Dixon's American Graphite Co., Alabama ranked second, and Pennsylvania third.

In the following table are given the statistcs of production of natural graphite in the United States, by States, in 1910:

Production and value of natural graphite in the United States, 1910, by States.

States.	Amorphous.		Crystalline.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Short tons.		*Pounds.*		*Short tons.*	
New York			2,605,000	$158,500	1,303	$158,500
Pennsylvania			1,392,767	82,194	696	82,194
Other States [a]	35,945	81,443	1,592,825	55,039	36,741	136,482
Total	35,945	81,443	5,590,592	295,733	38,740	377,176

[a] Includes Alabama, Alaska, Colorado, Georgia, Michigan, Nevada, and Wisconsin.

Production of natural graphite, 1906–1910.

Years.	Amorphous.		Crystalline.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Short tons.		*Pounds.*		*Short tons.*	
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
1910	35,945	81,443	5,590,592	295,733	38,740	377,176

Imports.—The imports for consumption of graphite into the United States in 1910 came mainly from Ceylon and Mexico and were nearly the same in quantity and value as in 1909. It is significant to compare the total value of the imports, $1,872,592, with the total value of the domestic product, both natural and artificial, which was $1,322,176. The domestic demand for graphite and graphite products is undoubtedly increasing, and it is encouraging to note that this demand is being met principally by increased domestic production rather than by increased importation. Domestic flake graphite is replacing the Ceylon graphite to some extent in the manufacture of crucibles for the metal industries. There appears to be no reason why this replacement should not increase, for in Germany flake graphite similar to much of the American product has for generations been successfully applied to this use.

The following table gives the statistics of imports for the last five years:

Imports for consumption of graphite into the United States, 1906–1910, in short tons.

Years.	Quantity.	Value.
1906	25,487	$1,554,212
1907	22,939	1,777,389
1908	11,456	762,367
1909	21,267	1,854,459
1910	25,235	1,872,592

WORLD'S PRODUCTION.

The world's production of natural graphite for the years 1907, 1908, and 1909, as gathered from various Government publications, is as follows:

World's production of graphite, 1907, 1908, and 1909, in short tons.

Countries.	1907		1908		1909	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
United States	29,277	$296,970	2,587	$208,090	8,243	$345,509
Austria	53,013	387,930	48,970	349,118	45,194	320,380
Canada	579	16,000	251	5,565	864	47,800
Ceylon	36,406	2,889,596	28,916	2,593,160	28,660	2,587,531
France	138	1,206	......	......	......	......
Germany	4,409	47,671	5,340	60,264	7,716	63,111
India	2,725	35,949	3,218	69,814	3,527	79,536
Italy	12,125	61,374	14,235	71,758	12,787	70,445
Japan	115	5,222	195	8,592	220	8,492
Mexico	3,530	54,339	1,742	28,426	(a)	(a)
Norway	1,543	14,974	1,192	13,005	......	......
Sweden	36	946	73	2,046	73	2,046
Queensland	34	965	22	292	22	290
Total	143,930	3,813,142	106,741	3,410,130	107,306	3,525,140

a Statistics not available.

ARTIFICIAL GRAPHITE.

As shown in the following table, the production of artificial graphite at Niagara Falls, N. Y., in 1910 was reported to be nearly twice that in 1909. The average price per pound was the same as in 1909.

Production and value of artificial graphite, 1906–1910.

Years.	Quantity.	Value.	Price per pound.
	Pounds.		*Cents.*
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
1910	13,149,100	945,000	7.20

INDUSTRY BY STATES AND TERRITORIES.

ALABAMA.

Graphite is widely distributed among the metamorphic rocks of Alabama,[1] in which it occurs in two forms: (1) In the feebly crystalline schists which have been called the Talladega slates,[2] and which in part at least are Paleozoic sediments of as late age as the "Coal Measures," graphite is often found as a black graphitic clay free from grit. In this condition the graphite is difficult to separate from the other matter with which it is mixed and the material has not as yet been utilized commercially to any important extent. Examples of this mode of occurrence may be seen near Millerville, in Clay County, and about Blue Hill, in Tallapoosa County. (2) In the mica schists and other highly crystalline rocks graphite is found in the form of thin crystalline flakes which may be separated from the associated minerals. Graphitic schists of this type are now being worked at three localities and have in the past been worked at several others.

The more important localities where flake graphite occurs were visited by the writer in the spring of 1911 and are briefly described below.

CLAY COUNTY.

The two properties which are at present the leading producers in Alabama are located 4½ and 8 miles west of Ashland. Ashland, the shipping point, is the terminus of a short branch of the Atlanta, Birmingham & Atlantic Railroad. This branch is 7 miles long and joins the main line at Pyriton. The freight rate on refined graphite from Ashland to New York City is about $7 per long ton.

Allen Graphite Co.—The quarry and mill of this company, which at present is the largest producer in the State, are located a little over 8 miles west of Ashland, at a settlement shown on the United States Geological Survey's map of the Ashland quadrangle under the name "Graphite." The mine is about one-half mile from the mill, with which it is connected by a tramway. The concentrate is hauled over a fairly good road to Ashland for shipment. The mining is entirely from open pits, and because of the decomposed character of the rock can be accomplished largely with the aid of pick, shovel,

[1] Smith, E. A., Min. Industry, vol. 16, 1907, p. 568.
[2] McCalley, H., Geol. Survey, Alabama, Rept. valley regions, pt. 2, 1897, pp. 36–38.

and crowbar, without much drilling and blasting. The main pit is about 450 feet in length, 100 feet in average width, and about 60 feet in maximum depth. A small pit just east of the main pit and on the same graphitic band is about 100 feet long, 90 feet wide, and 25 feet deep. A third pit has been opened on the same band of graphitic schist about 1,000 feet east of the main pit on the west face of another hill. This is about 90 feet wide, about 200 feet long, and about 40 feet deep. The strike of the schist at the north end of the main pit is N. 80° E., with a dip of 75° S. This is fairly typical for the deposit as a whole.

The rock mined is highly schistose and is composed largely of quartz and graphite. A white, fibrous mineral, probably sillimanite, is also abundant. Feldspar and mica are rare. Few of the thin graphite flakes so far seen by the writer exceed 2 millimeters across and most of them under 1½ millimeters. They are arranged subparallel to one another, and to this arrangement and a similar orientation of the sillimanite (?) prisms is largely due the schistosity of the rock. At the west end of the main pit a dike of coarse granite, 1 to 1½ feet wide, parallels the foliation of the schist, and in the easternmost pit the graphitic schist has also been intruded by an irregular body of coarse granite pegmatite carrying muscovite crystals up to 3 inches across. The graphitic beds here are also disturbed by faulting. The contact metamorphic effects of these small intrusions on the graphitic schist appear to be slight.

The milling process is divided into three principal stages: (1) Crushing and drying; (2) preliminary wet concentration; and (3) final dry concentration. The details are shown in figure 1.

The most important step in the milling process is the preliminary concentration by water flotation. In these concentrators the dry crushed rock is spread in a thin stream upon the surface of slowly flowing water. The graphite being flaky is supported by the surface tension of the water and floats off while the granular gangue, mainly quartz, sinks and is sent to the dump. The process is cheap where water is plentiful. The tailings seen on the dump carry surprisingly little graphite; that which is present is usually attached to other minerals. Much fine grit of course floats off with the graphite but is removed in the final dry concentration.

The crude rock is said by the operators to average about 5 per cent graphite. For two successive years (September, 1908, to September, 1910), the finished product formed, respectively, 2.95 and 2.7 per cent by weight of the crude rock treated. Four principal grades are produced whose relative proportions are about as follows:

Grades of flake graphite produced by Allen Graphite Co., Clay County, Ala.

	Per cent.
Grade C. Crucible flake	36
Grade 1. Lubricating flake (coarse)	11
Grade 2. Lubricating flake (fine)	18
Grade D. Dust for foundry facings, etc	35
	100

The highest grade contains over 90 per cent graphite; the dust averages about 50 per cent graphite. The prevailing average prices f. o. b. New York are: Grade C, 6½ cents per pound; grade 1, 5½ cents per pound; grade 2, 4¼ cents per pound; and grade D, 1 cent per pound.

Ashland Graphite Co.—The quarry and mill of this company, which is the successor to the Enitachopco Graphite Co., are located about 4½ miles west of Ashland. The product of the plant is hauled by team to Ashland. The workings at this property consist of two open pits located in the same belt of graphite schist. The two pits are on neighboring knolls, and the mill is in the small valley between them. The largest or eastern pit is about 400 feet long, 30 to 50

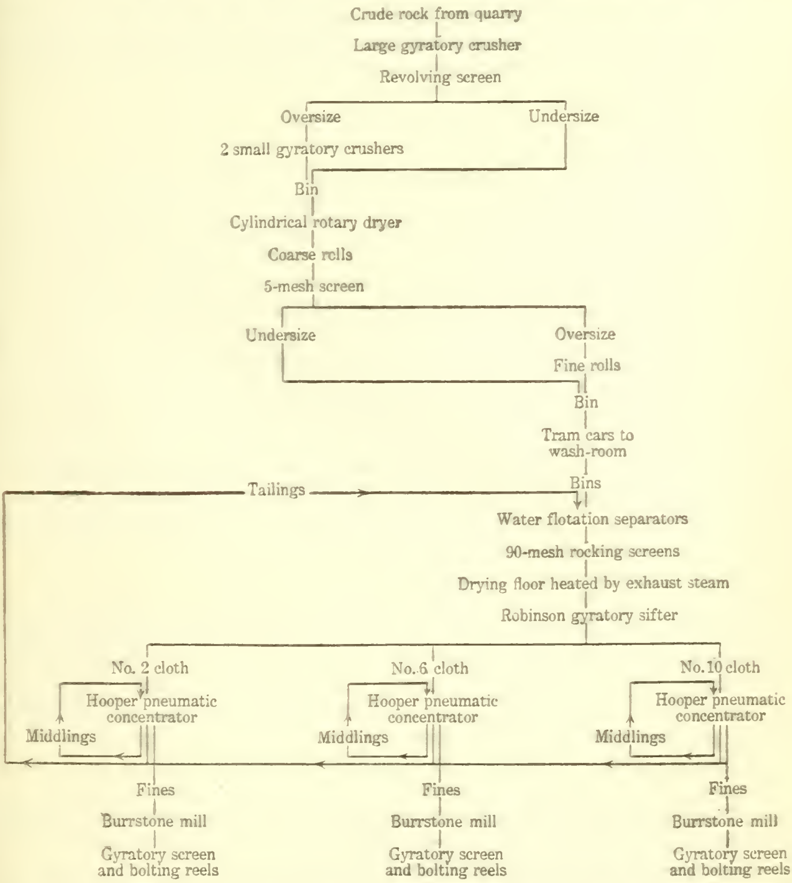

FIGURE 10.—Diagram showing milling processes at Allen graphite mill, Graphite, Ala.

feet wide, and 50 feet deep. It follows along the strike of a band of graphitic schist which averages about 30 feet in width, though broadening locally to about 50 feet. The strike is about N. 55° E. and the average dip is about 45° E. The second pit, located west of the mill, is about 150 feet long, 20 feet wide, and about 20 feet deep. The trend of the schists is similar to that at the larger pit.

The graphitic rock at this quarry is similar in general to that at the Allen quarry. The schist is too much decomposed for the complete identification of all the minerals, but quartz is the principal component. As a rule mica is rare, but the brown mica biotite is common in a few places. The graphite forms thin flakes, mostly under 1 millimeter in diameter, although some reach 2 millimeters. No igneous rocks were seen in association with the graphitic schist at this property. The rock being more or less decomposed can be excavated with pick and crowbar with occasional blasting. It is loaded into tramcars and hauled to the mill.

The mill has a capacity of about 50 to 60 tons per day of 12 hours. The milling process is in general similar to that at the Allen mill, though differing in details. A dry pan is used in preliminary crushing. The water flotation separators are similar to those at the Allen plant. The final dry concentration is accomplished by screens and burrstone mills without the use of Hooper pneumatic concentrators.

CHILTON COUNTY.

Dixie Graphite Co.—The property of this company is about 6 miles northeast of Mountain Creek, the shipping point, a small station on the Louisville & Nashville Railroad. The company has been out of business for many years and the mill is partly ruined. Two Jeffrey vibratory screens and a rotary drier are all that remain of the milling machinery. The graphitic rock was taken from several small open pits and a short tunnel on the slopes of a small creek valley. The creek is of sufficient size to furnish water for wet concentration but not for power. The tunnel is about 50 feet long and is enlarged at its end to a room about 50 by 50 feet and 15 feet high. The rock is a graphitic quartz schist interbanded with schist rich in muscovite. The general strike is about N. 70° W., and the dip is about 60° N. Quartz lenses are abundant. The graphitic portions are pockety in their distribution, and the flakes are small. For these reasons and because of its distance from the railroad the property is much less promising commercially than others in the State.

Flaketown Graphite Co.—This company operates a quarry and mill in the valley of Chestnut Creek, about 3½ miles northeast of Mountain Creek station. The property is about 3 miles west of that of the Dixie Graphite Co. The graphitic rocks lie in the west valley slope and have been developed by a small open pit. South of this pit sufficient prospecting has been done to show that the deposit is of very considerable size. The rock is a graphitic quartz schist very similar to those worked in Clay County. On account of its situation on a steep valley slope, which favors relatively rapid removal of weathered material, the remaining material is not so much decomposed as the deposits west of Ashland, in Clay County.

Small quantities of green micaceous mineral, probably muscovite, are present in some specimens, but in general, mica is rare. The strike of the schist folia at the main pit is N. 35° W., with a dip of 45° SW. A few hundred yards farther south the strike shifts to N. 20° W. and N. 15° W. A dike of granite pegmatite 1 foot wide intrudes the graphitic schist at the main pit. It parallels the foliation, and within 1 to 2 inches of the schist carries graphite in scattered flakes up to one-eighth of an inch in diameter.

An analysis made by the United States Geological Survey of a composite sample of graphitic schist, collected from a number of different exposures on this property, showed 4.63 per cent of graphite.

The mill is located at the quarry, and during part of the year electric power for its operation is generated by water power from a 20-foot dam on Chestnut Creek. Auxiliary steam power is also installed. The details of the concentrating process were not observed. Very little material has yet been marketed, the plant being still in an experimental stage. Mountain Creek is the nearest shipping point.

COOSA COUNTY.

A graphite prospect is located about 2 miles northwest of Goodwater, a station on the Central of Georgia Railway. At this locality a large number of small prospect pits are scattered over an area of several acres, and nearly all show graphitic quartz schist. The prospects are on a steep southwest hillside overlooking the iron bridge where the wagon road from Goodwater to Pine Grove crosses Hatchet Creek. The rock is gray when fresh and highly schistose and strikes nearly east and west, with a dip of about 45° S. It is almost identical in character with the graphitic schist worked in Clay County and consists largely of quartz and graphite, the latter in flakes mostly under 1 millimeter in diameter. Very little mica is present. An analysis of a composite sample of graphitic schist collected from a large number of pits on this property showed 2 per cent of graphite, but in certain portions the percentage will undoubtedly be greater. The deposit is unquestionably a large one and its situation on a steep hillside would afford opportunity to work to a considerable depth by open-pit methods. The neighboring Hatchet Creek would furnish abundant water for wet concentration of the graphite.

A second deposit, probably of similar character, has been prospected between Mount Olive and Hollins. It was not visited by the writer, but is said to be of considerable size.

COLORADO.

In Colorado the Federal Graphite Co. continued to be the only producer in 1910. Its product, which is amorphous, was shipped to the company's mill at Warren, Ohio, for grinding. The property was described in the report on graphite in 1909.[1]

GEORGIA.

The Emerson Brick Co. quarries graphitic slate at Emerson, in Bartow County, for use as a filler in fertilizers. An analysis of this material made by Prof. H. C. White, of the University of Georgia, showed 5.12 per cent of carbon. A second company quarrying similar material near Emerson is the American Chemical & Mining Co. Its rock is said to average 2 to 3 per cent graphitic carbon. On account of the fine amorphous character of the graphite no concentration is attempted, but the rock is simply crushed and ground. It sells at $1.25 to $1.50 per short ton, f. o. b. mills. The geology of these properties has been described by Hayes and Phalen.[2]

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[1] Bastin, Edson S., Graphite: Mineral Resources U. S. for 1909, pt. 2, U. S. Geol. Survey, 1911.
[2] Graphite deposits near Cartersville, Ga.: Bull. U. S. Geol. Survey No. 340, 1908, pp. 463-465.

NEW YORK.

Four firms produced natural graphite in New York during 1910. These were the Dixon's American Graphite Co., at Graphite, in Warren County; the Empire Graphite Co., at Greenfield, in Saratoga County; the Crown Point Graphite Co., in the town of Crown Point; and the Sacandaga Graphite Co., of Albany, which took over the property of the Glens Falls Graphite Co. in January. This property is located at Conklingville, Saratoga County. On the property of William H. Faxon, adjoining the Dixon property at Graphite, exploratory drilling was conducted, with encouraging results. The total production was slightly in excess of that for 1909.

The graphite deposits of New York were described in detail in the reports on graphite in 1908 and 1909.[1]

PENNSYLVANIA.

The production of graphite in Pennsylvania in 1910 showed a decrease of over 33 per cent in quantity and of over 29 per cent in value, as compared with 1909. The Acme Graphite Co. continued development work at its property near Byers. The American Flake Graphite Co., with plant at Kimberton, was a large producer and is reported to have purchased the property of the Federal Carbon Co. Other producers were the Chester Graphite Co., of Chester Springs, and the Pennsylvania Graphite Co., of Byers. The Crucible Flake Graphite Co. is out of business, and its plant, 1 mile northwest of Chester Springs, has been dismantled. The quarry and mill of the Sterling Graphite Co. at Chester Springs was sold in August to the Rock Graphite Mining & Manufacturing Co.

The Pennsylvania deposits are described in detail in the report on graphite in 1909.[2]

VIRGINIA.

Graphite is found in Virginia at a number of localities in the Piedmont region east of the Blue Ridge.[3] Near Somerset station in Orange County on the Somers place a large exposure of graphitic schist occurs, and at the same place much graphite is reported mixed with pyrite in a pyrite vein. In Louisa County, near Green Spring, specimens of graphite of considerable purity are found. Good specimens of the mineral have also been obtained on the road from Drakes Branch to Saxe in Charlotte County. It is reported from near Jefferson post office in Powhatan County.

A graphite mine was opened some years ago about 2 miles west of Buck Mountain in the northern part of Albemarle County by the Naylor-Bruce Graphite Co. The mine has been idle for several years, and the openings were so covered at the time of the writer's visit in April, 1911, that very little could be seen of the geology of the deposit. The mine is on a northeast hillside on the farm of W. A. Naylor. A lower pit only 20 feet above the creek level is about 10 by 10 feet and 15 feet deep, and was water filled. The rock exposed

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[1] Mineral Resources U. S. for 1908 and 1909, U. S. Geol. Survey.
[2] Mineral Resources U. S. for 1909, U. S. Geol. Survey, 1911.
[3] Watson, Thomas L., Mineral resources of Virginia, 1907, pp. 188–190. Published by Jamestown Exposition Commission.

near the pit is a mottled green and gray rock of somewhat gneissic texture, which is stated by T. L. Watson to be a pyroxene syenite. The principal working is a short distance higher up in the hillside, and consists of an open pit 40 by 30 feet and 12 feet deep, and of a shallow shaft. A small shaft house has been erected. The principal wall rock is the pyroxene syenite, which strikes N. 60° E. and dips about 80° SE. This syenite is intruded by diabase dikes, one dike at this pit being 14 inches wide, and by a 3-inch dike of pegmatite much weathered but showing feldspar crystals up to three-fourths of an inch and quartz crystals up to one-half inch across.

Graphite is exposed only on the south wall of the open pit where the rocks are much weathered. Here there is a single vein cutting the pyroxene syenite and varying from 1 to 2 inches across. This sends off into the syenite numerous short branches up to three-fourths of an inch across. The vein is composed largely of graphite with little or no gangue material. The graphite is in part earthy in texture, but in other places is crystalline with a well-developed fibrous structure. Some hand specimens forwarded to the Survey show some of the graphite fibers oriented at right angles to the sharply defined walls of the vein, but in other specimens they curve through angles of over 90°, possibly as a result of movement along the vein. In some places the fibers even lie parallel to the vein walls. The property is said to have yielded single blocks of graphite weighing several hundred pounds. An analysis by Froehling and Robertson, of Richmond, gave 76.28 per cent of graphitic carbon.

In general the exposures were too poor to reveal much in regard to the origin or probable extent of the deposit.

OTHER STATES.

Alaska.—Crystalline graphite imported from Alaska by the Alaska Graphite Co. was ground in San Francisco and used principally for foundry facings.

Arkansas.—In Arkansas development work was in progress during 1910 on a graphite property 2 miles north of Mountainsburg, in Crawford County, but no material was marketed. The material is reported to run from 40 to 60 per cent graphite.

Michigan.—In Michigan the Detroit Graphite Co., quarrying graphitic slate near L'Anse, in Baraga County, was the only producer. The product was pulverized without concentration for use as a paint pigment at the company's plant at Detroit.

Montana.—In Montana the Crystal Graphite Co. continued development work on its property near Dillon, but no material was marketed.

Nevada.—In Nevada the Carson Black Lead Co. continued to mine amorphous graphite from its property 3 miles from Carson for use in making paint.

Utah.—In Utah the Homber Mining Co., with mine near Brigham City, in Boxelder County, did not operate during 1910.

Wisconsin.—In Wisconsin the only producer was the Wisconsin Graphite Co., with mine near Junction City. The product, which is amorphous, is crushed, dried, and pulverized in a mill at Stevens Point. No concentration is attempted.

MARKETS AND PRICES.

The reports upon market conditions were very divergent even among graphite producers in the same district. This fact indicates the extent to which success in the graphite industry is dependent upon the processes of treatment adopted and the cleanness of the product obtained. The production being sporadic and of uneven grade, regular markets have been established only in a few instances. By most producers market conditions were reported as fair or good. A few of the larger operators reported a decreased demand for their product, due probably to a cutting in upon their markets by some of the newer producers. The prices f. o. b. mills for refined flake graphite were approximately as follows: For the coarsest flake, running over 90 per cent graphite, the price ranged from 6 to 8½ cents per pound; for the dust, from one-half cent to 2 cents per pound; amorphous graphite from Colorado brought $50 to $70 per ton, according to purity.

LITERATURE.

A bibliography of the most important publications dealing with graphite in the United States was published in the report on the production of graphite in 1909.[1] The most important recent publication dealing with this mineral is a book by Dr. O. Stutzer,[2] of the University of Freiberg, Saxony, dealing with the geology of graphite, diamond, sulphur, and phosphates. In a chapter of 88 pages Dr. Stutzer describes the mode of occurrence and origin of graphite deposits in all parts of the world. This is unquestionably the best discussion that has ever been published of the geology of graphite deposits. Uses and methods of milling are treated only briefly.

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[1] Mineral Resources U. S. for 1909, pt. 2, U. S. Geol. Survey, 1911, pp. 835-840.

[2] Stutzer, O., Die wichtigsten Lagerstätten der "Nicht-Erze" (the more important deposits of non metallic minerals). Borntraeger Brothers, Berlin, 474 pages 108 text figures, 1911.

MAGNESITE.

By Charles G. Yale.

PRODUCTION.

The only deposits of magnesite in the United States which have been commercially utilized are those situated in the valley and coast counties of California. In 1910 the California mines made an output of 12,443 short tons of crude magnesite, valued at $74,658, as compared with 9,465 tons in 1909, valued at $37,860. This shows a material increase both in quantity of product and in value for the year 1910. It is indeed somewhat difficult to place any exact market value on this substance, as the price varies materially in different localities, according to conditions of mining and to freight rates to centers of utilization. The price of $6 per ton placed on the crude ore for 1910 is one-third higher than the price in 1909, and yet there are many quotations of $7 per ton and even much higher, while, as a matter of fact there is none offered on the market for either price. This may be explained by the fact that during 1910 no crude ore was sold by any of the productive mines, as they calcined all their ores before attempting to market them. By far the largest proportion of the entire output of California magnesite was consumed by the manufacturers of paper from wood pulp in California and Oregon, and only the calcined material is suitable for their purposes. A certain quantity was also used by the makers of artificial stone, tiling, flooring, and building material, who also use only the calcined magnesite. For these reasons no crude ore is offered for sale, while the calcined is in good demand for the uses stated. The entire front of one large building in San Francisco was recently constructed of molded calcined magnesite in blocks and in ornaments. The material was first calcined and then ground to a fine powder and was then made into a plastic cement and molded in the desired forms.

In addition to the quantity of crude magnesite ore produced in California in 1910, as stated above, one of the active mining companies also mined 2,272 tons of what is called "magnesite clay," which, when pulverized, has a market value of $10 per ton.

The prevailing price for calcined magnesite when sold in large quantities to regular consumers on contract basis in 1910 was about $16 per ton. Yet much higher prices were brought for a superior article when sold in small lots or when pulverized sufficiently to be suitable for plastic operations. Under these circumstances it has sold as high as $25 per ton in San Francisco and as high as $35 per ton in Los Angeles. Since the close of 1910 the price for large lots of calcined magnesite may be said to have increased materially, nor does it seem liable to decline, unless larger and newer deposits than those now being worked are opened. It takes from 2 to 2.6 tons of crude ore to make one ton of calcined magnesite, depending on the purity of the original ore and the extent to which the roasting is carried on.

Although seven mines reported production of magnesite in California in 1909 only four were productive in 1910. All of these are equipped with furnaces and able to furnish the calcined product. Other mines, with no furnaces for calcining, remained idle, and still others were not worked by their owners because they considered the market price too low in view of the gradual increase in local consumption each year. These owners prefer to wait for better prices, being convinced they will shortly come as the uses of the substance increase and its value becomes better understood and known.

There are numbers of deposits known in Fresno, Napa, Riverside, Santa Clara, Sonoma, Alameda, Placer, San Luis Obispo, Kern, Stanislaus, Mendocino, San Benito, Mariposa, Tuolumne, and Tulare counties. In 1910 the larger proportion of the output was derived from single mines in Tulare and Santa Clara counties, smaller quantities having been mined in Fresno and Riverside counties. Only a few of these known deposits have been developed to any great degree and in most cases their extent is still undetermined. Under the stimulus of advanced prices and increased local demand, doubtless several of these deposits will be developed to determine their actual value. Thus far, however, only the mines in Tulare and Santa Clara counties have been sufficiently opened to demonstrate their extensive character.

The sale of California magnesite is virtually limited to localities on the Pacific coast, the cost of transportation to points of consumption east of the Rocky Mountains being prohibitive. It is for this reason that such large quantities of raw and calcined magnesite continue to be imported from Greece and Hungary. It is doubtful, however, in the present state of the development of the mines of California, if they could produce enough annually to satisfy the demand in the United States, even if the bar of high freight rates were removed and a heavy import duty imposed.

USES.

In the crude state magnesite is used for the manufacture of carbon dioxide gas; calcined, it is used in the manufacture of paper from wood pulp; and as a refractory material it is used in brick or plaster form for lining furnaces, covering steam pipes, as artificial stone, as composite stone for lithographing, as an adulterant for paint, etc. Magnesium chloride is an excellent bleaching agent. The light carbonate of magnesia (alba levis) is used for medicinal and toilet purposes. The sulphate, known as Epsom salts, is mainly used in warp sizing or weighting in cotton mills, and lesser quantities are used for medicinal purposes. The hydrate is used in sugar manufacture.

Calcined magnesia, generally in the form of brick, is now universally recognized as the best material for lining basic open-hearth furnaces, copper-smelting furnaces, cement kilns, etc. It may be employed to advantage wherever high temperatures and chemical reactions are usually detrimental to dolomite, chromite, and silica brick. The distinctive characteristics of a magnesite lining are durability, freedom from moisture and silicic acid, and resistance to corrosion when exposed to the action of basic slags and metallic oxides.

Sintered magnesite tubing of assorted sizes is regularly made for chemical and electrometallurgical work; and magnesite crucibles are made of various forms and different degrees of fineness. A coating of crushed magnesite is also sometimes laid on hearths for heating steel stock for rolling to prevent the scale formed from attacking the fire brick of the hearth. The calcined is also used in the manufacture of boiler and steam-pipe covering, stoppers, sleeves, hot-metal ladles, tuyeres, and nozzles.

As a building material calcined magnesite is most largely used for constructive fireproof flooring and tiling. But it is also made into artificial stone and marble, hollow tile, drain pipe, partitions, staircases, wainscoting, tanks, trays, washtubs, ornamental moldings, building blocks, cement, doorways, window casings, etc. Experiments are under way in California for making a protective paint for both wood and metal construction work to prevent corrosion or fire. It has lately come into quite extensive use as a flooring in steel railroad cars, being mixed with other substances to make it plastic so it may be laid in one continuous piece without seams. The fine waste of the crude ore mined is now being utilized in the California chicken ranches as a substitute for oyster shells and other substances fed to fowls for hardening the eggshells.

The following table shows the quantity and value of the domestic output from 1891 to 1910, inclusive:

Quantity and value of crude magnesite produced in the United States, 1891–1910.

Years.	Short tons.	Value.	Years.	Short tons.	Value.
1891	439	$4,390	1901	3,500	$10,500
1892	1,004	10,040	1902	2,830	8,490
1893	704	7,040	1903	3,744	10,595
1894	1,440	10,240	1904	2,850	9,298
1895	2,220	17,000	1905	3,933	15,221
1896	1,500	11,000	1906	7,805	23,415
1897	1,143	13,671	1907	7,561	22,683
1898	1,263	19,075	1908	6,587	19,761
1899	1,280	18,480	1909	9,465	37,860
1900	2,252	19,333	1910	12,443	74,658

IMPORTS.

Both crude and calcined magnesite are annually imported into the United States in large quantities, and these quantities seem to be yearly increasing. In 1910 the quantity of crude imported was 52,002,557 pounds, valued at $162,069, and of calcined but not purified 297,652,901 pounds, valued at $1,380,731. The prices quoted are the wholesale prices of 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 1909 and 1910 were as follows:

Imports of magnesite into the United States in 1909 and 1910, in pounds.

	1909		1910	
	Quantity.	Value.	Quantity.	Value.
Magnesia:				
Calcined, medicinal	52,247	$8,697	61,471	$9,519
Carbonate of, medicinal	49,115	3,328	46,926	2,799
Sulphate of, or Epsom salts	6,612,956	28,180	6,748,388	23,565
Magnesite:				
Calcined, not purified	208,947,602	939,014	297,652,901	1,380,731
Crude	19,635,479	46,005	52,002,557	162,069

The total value of the imports of magnesia and magnesite into the United States in 1910 was $1,578,683, as compared with $1,041,418 in 1909. It is to be noted also that the increase in quantity of imports of calcined in 1910 was 88,705,299 pounds over the imports of 1909, and the increase of crude for the same period was 32,367,078 pounds. In 1908 the imports of calcined amounted to 129,462,109 pounds and of crude to 39,526,865 pounds. The largest proportion of these imports came from Austria-Hungary, but considerable quantities came from Greece and smaller quantities from Germany, Netherlands, Norway, England, and Canada.

During the year 1910 the Compañía Mexicana de Magnesita, of Los Angeles, Cal., opened magnesite properties on Santa Margarita Island, Magdalena Bay, Lower California, Mexico, and brought 1,500 tons of crude ore to the port of San Diego, Cal., for the use of the Durostone Co. of America, a Los Angeles corporation. This latter company established an extensive plant at Chula Vista, 8 miles from San Diego, but thus far has not commenced manufacturing operations. A few hundred tons of crude magnesite were also imported from Mexico to San Pedro, the port of Los Angeles, Cal.

MICA.

By Douglas B. Sterrett.

INTRODUCTION.

Several varieties of mica are known, but only two—muscovite and phlogopite—have been used extensively in industrial work. Within the last three years, however, small quantities of biotite have been used for commercial purposes. Another variety, lepidolite, has been used as a source of lithium salts. Chemically, muscovite is a silicate of aluminum and potassium containing water; phlogopite is a silicate of magnesium, aluminum, and potassium; and biotite is a silicate of magnesium, iron, aluminum, and potassium. Phlogopite and biotite may be placed at opposite ends of a chemical series and may grade into each other by variations in the percentage of iron present. In thin sheets muscovite is nearly colorless and is sometimes called "white" mica. Phlogopite is generally yellow or brownish and is called "amber" mica. Biotite is dark brown to nearly black, even in thin sheets.

Several countries contribute to the world's production of mica, among which are India, the United States, Canada, Brazil, German Southwest Africa, and Japan. Some of these countries yield both muscovite and phlogopite mica, and others but one variety. Muscovite is the only mica so far found in deposits of commercial value in the United States; a little biotite has been produced during the operation of some of the deposits of muscovite. Mica deposits of value, or of promise, are known to occur in more than 20 States of the United States. The following States have been the principal producers of mica: North Carolina, South Dakota, New Hampshire, Virginia, Idaho, Colorado, South Carolina, Georgia, Alabama, and New Mexico. Mica deposits are known to occur in the following States and the prospects at some of the deposits are promising: Maine, Vermont, Massachusetts, Connecticut, Pennsylvania, Maryland, Wyoming, Texas, Arizona, Utah, Nevada, and California. The occurrence of mica in the vicinity of Gallatin, Cherokee County Tex., has recently been reported by C. E. Rowbarts.

OCCURRENCE.

Mica is a mineral of widespread occurrence in the rocks of the earth's surface. It is a constituent of many metamorphic and igneous rocks and is found in the clastic rocks formed by their disintegration, erosion, and sedimentation. The occurrence of mica in the clastic rocks is generally limited to scales a fraction of an inch across, and is never of commercial importance. Mica suitable for industrial purposes is found in coarse-grained rocks. Muscovite is obtained from pegmatite and phlogopite is obtained from more basic rocks with a coarse texture, such as those composed largely of pyroxene. Pegmatite is a rock allied to granite in composition, with a coarser and more variable texture. The principal constituents are quartz and feldspar with or without mica and other accessory constituents, such as garnet, tourmaline, beryl, apatite, rare minerals, etc.

Mica-bearing pegmatites are generally associated with highly metamorphic rocks of great age. Common varieties of these rocks are muscovite, biotite, garnet, cyanite, staurolite, hornblende, and granite gneisses and schists. Deposits of commercial value also occur in granite that has not been strongly metamorphosed.

Pegmatites occur in irregular masses, streaks, and lenses which range from small size to many yards in thickness and length. The limit of size below which they can not be profitably worked for mica might be placed arbitrarily at 1 to 2 feet in thickness for rich and regular "veins." In the very large pegmatites the mica is not evenly distributed through the mass, but is richer in one portion than in another, so that the entire bulk of the rock does not have to be removed in mining. In such pegmatites the mica may occur in one or more streaks near the walls, or in the interior of the mass, or it may be found in clusters at intervals, with or without connecting streaks. In some places the mica crystals are partly embedded in the wall rock.

Mica occurs in rough crystals and blocks, which range in size from a small fraction of an inch to several feet across. A crystal found in the Iotla Bridge kaolin and mica mine, in Macon County, N. C., in 1907 measured about 29 by 36 inches across and was about 4 feet thick. The rough blocks as obtained from the mines generally yield only a small percentage of trimmed sheet mica. A yield of 10 per cent of sheet mica is very high, and the rest is only suitable for grinding.

USES.

Mica is used in large quantities in both sheet and ground form. Sheet mica is used in stoves, for gas-lamp chimneys, for lamp shades, and for glazing, and is punched into disks and washers or cut by shears operated either by hand or by power into patterns for use in stoves and electrical apparatus. 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, switchboards, lamp sockets, etc. The domestic or muscovite mica is satisfactory for all insulation except for commutators of direct-current motors and 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 machine to spark. A large quantity of the 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 under heat to dry out the shellac.

Sheet mica with black specks of magnetic iron between the laminæ is inferior to clear mica for electrical insulation. Such mica is used, however, in electrical apparatus conveying only currents of fairly low voltage. This variety of mica is satisfactory if used with discretion, but some electrical manufacturers will not use it in any of their apparatus.

A large quantity of scrap mica—that is, mica too small to be cut into sheets and the waste from the manufacture of sheet mica—is ground and used in many ways. Among these are the manufacture of wall papers, lubricants, and fancy paints, and of molded mica for electrical insulation. Ground mica applied to wall papers gives them a silvery luster. When mixed with grease or oils finely ground mica forms an excellent lubricant for axles and other bearings. Mixed with shellac or special compositions, ground mica is molded into desired forms and is used in trolley wire and other insulators. Ground mica for electrical insulation must be free from metallic minerals. Mica used for lubrication should be free from gritty matter. 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 to prevent the tar or other composition used in its manufacture from sticking when the material is rolled for shipping.

PRODUCTION.

The total value of the mica produced in the United States in 1910 amounted to $337,097. The production came from seven States—North Carolina, South Dakota, New Hampshire, Colorado, South Carolina, New Mexico, and Massachusetts—named in the order of the value of their output. South Carolina and New Mexico returned to the list of mica-producing States in 1910, no production having been reported from these States in 1909. A small output was reported from Massachusetts, which had reported no production for several years. Virginia, Alabama, New York, Georgia, and Maine failed to report an output of mica in 1910, though each reported a production in 1909. The value of the production of mica in 1910 was greater by $56,568 than in 1909, and was greater than in any other year except 1907, when it amounted to $392,111.

The production of sheet mica amounted to 2,476,190 pounds, valued at $283,832, an increase of 666,608 pounds in quantity and of $49,350 in value, as compared with the output of 1909. The production of sheet mica reported from the different States each year is quite variable and it is difficult to make a distinction between the small sheet mica for punched forms and scrap mica. The variation is also due in part to the fact that in some years some of the producers complete the manufacture of more of their mica than in other years, thus reporting smaller quantities of sheet mica and larger quantities of scrap mica than in years when less of the mica is trimmed into sheets. In 1910 the largest production of sheet mica was reported from South Dakota, but in 1909 the largest production was reported from North Carolina.

The production of scrap mica amounted to 4,065 tons, valued at $53,265, a decrease of 25 tons in quantity and an increase of $7,218 in value, as compared with the figures for 1909. The increased value was due to an improvement in the price of scrap mica in North Carolina, which furnished nearly three-fourths of the total production.

The value of the production of mica in North Carolina in 1910 was $230,460, as compared with $148,424 in 1909, an increase of $82,036. The production reported in 1910 consisted of 455,020 pounds of sheet mica, valued at $193,223, and 3,074 short tons of scrap mica, valued at $37,237. The production in 1909 consisted of 1,296,274 pounds of sheet mica, valued at $122,246, and 2,607 short tons of scrap mica, valued at $26,178. It is evident that a large quantity of small mica was reported as scrap in 1910 and that a similar quantity was reported as sheet in 1909, and, further, that the production for 1910 included a quantity of manufactured mica. The output of sheet and scrap mica reduced to short tons amounted to about 3,302 tons in 1910, as compared with about 3,255 tons in 1909. Thus the quantity of production was not greatly different in the two years. The production of mica in North Carolina in 1910 came from Mitchell, Yancey, Macon, Jackson, Cleveland, Madison, and Transylvania Counties and from over 150 producers. In the other States the production of mica was limited to one or two producers and the figures are therefore not given by States.

The production of mica in the United States since 1880 is given in the following table:

Production of mica in the United States, 1880–1910.

Year.	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	360,000	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
1910	2,476,190	283,832	4,065	53,265	337,097

PRICES.

The average price of sheet mica in the United States during 1910, as deduced from the total production, was 11.5 cents per pound, as compared with 12.9 cents per pound in 1909. The average price of sheet mica in North Carolina was 42.5 cents per pound; in New Hampshire, 22.3 cents; in South Dakota, 3.6 cents. The average price of scrap mica in 1910, as deduced from the total production, was $13.10 per ton, as compared with $11.26 in 1909 and with $14.02 in 1908. The price of scrap mica in North Carolina was $12.11 per ton; in New Hampshire, $14.89; in South Dakota, $15.70; in Colorado, $22.

It is not possible to give absolute prices of manufactured sheet mica from the lists of the dealers, since discounts allowed vary with the nature of the purchases. The prices of the sizes given in the table below are quoted from a standard list for 1911. Discounts ranging from 70 to 10 per cent are allowed on stove mica and from 60 to 10 per cent on electrical mica.

Prices per pound quoted for stove and electrical mica for 1911.

Stove mica.		Electrical mica.	
Size.	Price.	Size.	Price.
Inches.		*Inches.*	
1½ by 2	$1.20	1 by 3	$1.75
2 by 2	2.00	1 by 6	5.50
2 by 3	3.50	1½ by 4	2.75
3 by 3	5.75	2 by 4	3.50
3 by 4	7.00	2 by 7	7.25
4 by 6	9.50	3 by 9	11.00

IMPORTS.

The imports of unmanufactured and trimmed sheet mica into the United States during 1910, as reported by the Bureau of Statistics of the Department of Commerce and Labor, amounted to 1,961,523 pounds, valued at $724,525. These imports exceeded those of 1909 by 114,872 pounds in quantity and $105,712 in value and were greater than those of 1908, but were less in both quantity and value than those of 1906 and 1907. The imports of cut or trimmed mica were considerably greater than in previous years. Ground mica to the value of $1,298 was imported in 1910, as against no imports recorded in previous years.

The quantity and value of mica imported into the United States annually from 1905 to 1910, inclusive, are shown in the following table:

Mica imported and entered for consumption in the United States, 1905–1910, in pounds.

Year.	Unmanufactured.		Cut or trimmed.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
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
1910	1,424,618	460,694	536,905	263,831	1,961,523	724,525

FOREIGN PRODUCTION.

INDIA.

The exports of mica from India[1] in 1909 amounted to 32,640 hundredweight, valued at £156,199 ($760,142), as compared with 27,572 hundredweight, valued at £139,513 ($668,950) in 1908. There was a decrease in production from 53,543 hundredweight in 1908 to 32,903 hundredweight in 1909. The average production of mica during the four years from 1904 to 1908 amounted to 41,219 hundredweight. The production comes from the following provinces,[2] named in the order of their importance: Bengal, Madras, and Rajputana. The average consumption of mica in India for decorative and ornamental purposes is about 400 tons annually.

CANADA.

The production of mica in Canada[3] during 1910 was valued at $143,409, as compared with $147,782, the revised figures for 1909. The quantity of mica produced in 1909 was 369 short tons. The exports of mica during 1910 amounted to 937,263 pounds, valued at $330,903, as compared with 717,066 pounds, valued at $256,834, in 1909.

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[1] Rec. Geol. Survey India, vol. 40, pt. 2, 1910.
[2] Rec. Geol. Survey India, vol. 39, 1910.
[3] Preliminary report on the mineral production of Canada in 1909, Dept. Mines, Canada.

MINERAL WATERS.

By George Charlton Matson.

INTRODUCTION.

In this report the term mineral water is used with about the same significance as in the preceding volumes of Mineral Resources. It is not possible to adopt a satisfactory scientific classification because the waters that are being sold vary greatly, and in addition to the natural variations many of the waters are subjected to certain treatment, such as carbonation or evaporation, before they are placed on the market. The statistics given refer to the commercial value of the waters when they are ready for the consumer; hence the report deals with waters that are sold. Certain waters that are commercially valuable are excluded. These are the waters used for public supplies, and the natural waters that have been subjected to sufficient changes to warrant their classification as artificial. Obviously the distinction between natural waters that have received some treatment and those that are regarded as artificial is arbitrary. The essential characteristics of a mineral water, as the term is used in this report, is that the water must either be natural or only slightly changed from its natural state; in addition it must be sold. Thus the term mineral water is made to include every gradation from waters that are very highly mineralized to those that contain only small quantities of matter in solution, and, moreover, no distinction is made between waters that are classed as medicinal and those that are merely regarded as pure.

MEDICINAL AND TABLE WATERS.

On the basis of use, the waters reported may be arranged in two groups, medicinal and table. This method of grouping does not permit sharp distinctions, for waters that are highly mineralized may be sold for domestic purposes, while those containing very small quantities of minerals in solution may be regarded as medicinal. However, the average amount of mineral matter in solution is higher in the waters sold for their therapeutic value than it is in those sold for ordinary use.

Probably the most common medicinal waters are those containing lithia, sulphur, or sulphates; another important class of waters has received considerable attention in recent years because of their radioactivity. It seems that there are a large number of springs containing small quantities of radium and possibly possessing important medicinal qualities. Probably the greatest amount of radioactivity is to be found in some of the thermal springs in the West. Since the radioactivity of the water diminishes rapidly after its emergence from the earth, it would be necessary to utilize the supplies at their source.

It may be that the benefits derived from the use of many of the waters are the result of the consumption of a plentiful supply of wholesome water, as it is a well-known fact that careful and systematic use of pure water is usually beneficial.

The so-called sulphur waters contain more or less hydrogen sulphide gas, which gives them a disagreeable odor. They are usually consumed at the springs and are not bottled. Probably the principal therapeutic value depends largely upon the various substances in solution in the sulphur waters. Inasmuch as these waters are usually highly mineralized this view appears credible.

The sulphate waters usually contain the sulphate radicle and such bases as magnesium and sodium, together with many other radicles and elements. These waters are often strengthened by the addition of magnesium sulphate (Epsom salts), or sodium sulphate (Glauber's salts), and their action is usually very pronounced.

Among the waters used for medicinal purposes lithia waters have extensive sales. They are usually sold in half-gallon bottles and are among the highest priced mineral waters.

Large quantities of water are sold for table use and the supplies from many important springs are used entirely for domestic consumption. In general, these waters are not highly mineralized, though in some places water sold for this purpose might also find a ready market for medicinal purposes.

Table waters may be grouped as natural (still waters) and carbonated waters. The demand for the former is much greater than for the latter, the still waters being often sold for less than 10 cents a gallon, while the carbonated waters may be worth four or five times as much.

SOURCE AND MINERALIZATION OF WATERS.

With the possible exception of a few thermal springs in regions of recent volcanic activity and of some salt springs, mineral waters are all derived from rainfall. Inasmuch as the meteoric waters are practically pure, the mineralization must take place after they enter the ground. In their passage through the earth these waters encounter an infinite variety of soluble materials, consequently the kind of material in solution will differ greatly. The quantity of soluble matter encountered is also variable and the amount of material dissolved differs in a similar way. The freedom of circulation and the length of the underground course of the waters also affects both quantity and quality of material in solution, because if the water is long in contact with soluble materials it is enabled to take them up in large quantities and there may be more or less redeposition of some substances and solution of others as the composition of the water changes. An excellent example of the effect of long contact with soluble materials is seen in many of the wells of the Atlantic Coastal Plain. Those wells that are nearest the outcrop frequently yield hard water, while other wells penetrating the same horizon at a greater distance from the place where the water enters the ground furnish alkaline water.

Some of the thermal springs in regions of recent volcanic activity may be supplied by water from volcanic rocks. It is a well-known fact that molten lavas coming from within the earth bring with them a quantity of water, and in the process of consolidation this water may be concentrated in crevices or porous rocks, to emerge finally in hot springs. Such springs are not numerous and it is practically impossible to differentiate them from thermal springs resulting from the heating of underground waters by the molten lava. It has also been suggested that fracturing and slipping of fractured beds has resulted in the heating of underground waters and the consequent production of thermal springs at some places.

Some of the water from saline springs may be oceanic water included in sedimentary beds at the time of their deposition. Other springs are supplied by saline water that has dissolved its salt and other substances from the formations through which they have passed. Inasmuch as strata in different localities have similar composition it follows that there may be general groupings of mineral waters, depending upon the character of the beds through which they have percolated. However, there is usually very great variation in the relative quantities of materials in solution, and consequently any classification based on the character of the water-bearing beds is necessarily artificial. Moreover, the physiologic action of various waters would differ so much that any commercial classification would need to have an entirely different basis than the geologic occurrence of the waters.

VALUE OF SPRING WATERS.

The statistics given in this report are based on the average selling price per gallon of the water at the spring. The quotations are those furnished by the spring owners and represent as nearly as possible the amounts received for the water exclusive of the value of the containers. There is a noticeable range in price between table waters sold in barrels and medicinal and carbonated waters put up in bottles. Owing to these variations, the average price of the water for a whole State has little significance, but the total values are useful because they show the relative values of waters used for different purposes and the relative magnitude of the mineral-water business in different States, as well as the total value of waters sold from springs that have furnished statistics.

IMPORTANCE OF THE MINERAL WATER TRADE.

It is not possible to determine the actual value of the mineral waters consumed because the statistics only show the quantity and value of the waters sold, and do not take into account the large quantities given away at the springs. At many of the springs there are hotels or other places of entertainment operated by the owners or managers of the springs, and guests at these places are seldom required to pay for the spring water. The quantities of artificial table water made by carbonating and often by adding mineral salts to ordinary water are very large. In addition, there are many artificial medicinal waters that have a large sale.

SOFT DRINKS.

The manufacture and sale of various beverages known as soft drinks has become an important industry, but the statistics are too fragmentary to give more than a general idea of its magnitude. In some places the water from mineral springs is utilized in the manufacture of soft drinks. The quantity thus used may not have been reported in all cases, but the figures given show that 6,403,913 gallons were used for this purpose, while the total mineral water sold for other purposes amounted to 62,030,125 gallons. The quantity of spring water reported to have been utilized in the manufacture of soft drinks is given in the following table:

Quantity of water used in the manufacture of soft drinks, 1910, by States, in gallons.

Wisconsin	2,151,782	California	130,000
Massachusetts	677,878	Colorado	121,250
Minnesota	629,350	Connecticut	118,415
New Hampshire	562,626	Other States	1,235,405
Pennsylvania	421,109		
Missouri	217,104	Total	6,403,913
South Carolina	138,994		

MINERAL WATER TRADE IN 1910.

OUTPUT AND VALUE.

The reports received from proprietors of springs show that the traffic in mineral waters in 1910 has fallen off from that of 1909. The total sales in 1909 amounted to 64,674,486 gallons; the sales in 1910 were 62,030,125 gallons. This is a reduction of 4.09 per cent and the difference in value amounted to $536,544. This reduction in value amounts to 7.78 per cent and is probably to be accounted for by the fact that in addition to the decrease in the quantity of water sold the average price fell from 11 cents per gallon in 1909 to 10 cents in 1910. The number of springs reporting sales in 1910 was 709, as compared with 760 in 1909 and 695 in 1908. Thus, although some of the gain since 1908 has been maintained, there was a distinct reduction in the number of springs in 1910. The springs which reported in 1909 and did not report in 1910 had a total production in 1909 of about 1,000,000 gallons, or less than 2 per cent of the sales reported in 1910. The following tables show the output of mineral waters from 1883 to 1910 and the details of the 1910 production:

Estimated production of mineral waters, 1883–1910.

Year.	Number of springs.	Quantity sold (gallons).	Value.	Year.	Number of springs.	Quantity sold (gallons).	Value.
1883	189	7,529,423	$1,119,603	1906	a 582	48,108,580	$8,028,387
1885	224	9,148,401	1,312,845	1907	a 584	52,060,520	7,331,503
1890	273	13,907,418	2,600,750	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
1900	561	45,276,995	5,791,805	1910	a 709	62,030,125	6,357,590
1905	a 564	46,544,361	6,491,251				

a Springs reporting sales.

Production and value of mineral waters in the United States, 1909 and 1910, by States.

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
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

1910.

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	9	133,159	$0.23	$23,179	$7,460	$30,639
Arkansas	10	1,065,676	.08	34,439	55,333	89,772
California	41	2,008,697	.20	137,491	257,350	394,841
Colorado	14	1,638,984	.07	22,133	93,156	115,289
Connecticut	24	1,608,775	.06	5,034	104,819	109,853
Florida	9	90,189	.16	2,019	12,250	14,269
Georgia	11	734,135	.09	37,172	25,999	63,171
Illinois	16	1,117,620	.07	2,485	80,663	83,148
Indiana	15	754,111	.68	493,680	21,278	514,958
Iowa	6	253,100	.11	7,400	19,775	27,175
Kansas	17	591,004	.14	64,677	17,630	82,307
Kentucky	12	403,736	.14	32,512	22,683	55,195
Louisiana	4	2,313,000	.07	10,155	153,820	163,975
Maine	29	1,238,171	.33	10,836	393,703	404,539
Maryland	8	1,163,828	.09	0	102,371	102,371
Massachusetts	55	4,691,159	.05	23,659	218,290	241,949
Michigan	17	1,454,020	.05	100	69,438	69,538
Minnesota	19	9,962,370	.03	4,585	276,424	281,009
Mississippi	7	309,450	.14	40,632	3,343	43,975
Missouri	27	657,035	.15	67,547	28,941	96,488
Nebraska	3	12,785	.12	750	779	1,529
New Hampshire	10	706,828	.29	184,817	18,014	202,831
New Jersey	11	1,583,050	.08	1,175	131,964	133,139
New Mexico	5	171,600	.18	7,380	22,780	30,160
New York	46	8,780,903	.10	167,022	691,613	858,635
North Carolina	15	143,007	.15	18,719	2,670	21,389

[a] Includes Delaware, District of Columbia, Idaho, Montana, Nebraska, North Dakota, Utah, and Wyoming.

Production and value of mineral waters in the United States, 1909 and 1910, by States—Continued.

1910—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.
Ohio	30	2,226,188	$0.04	$19,094	$76,895	$95,989
Oklahoma	4	115,000	.04	3,050	1,900	4,950
Oregon	7	88,970	.26	5,254	17,735	22,989
Pennsylvania	44	2,536,337	.09	49,423	172,262	221,685
Rhode Island	8	528,725	.07	0	34,703	34,703
South Carolina	15	410,691	.19	60,241	18,224	78,465
Tennessee	18	950,511	.07	60,822	10,307	71,129
Texas	31	1,241,248	.10	98,583	29,966	128,549
Vermont	5	137,875	.12	3,575	13,085	16,660
Virginia	40	2,441,923	.13	153,633	147,890	301,523
Washington	4	31,200	.40	3,530	9,041	12,571
West Virginia	13	336,444	.24	61,595	20,147	81,742
Wisconsin	36	6,400,812	.15	88,383	885,983	974,366
Other States [a]	14	997,809	.08	1,235	78,890	80,125
Total	709	62,030,125	.10	2,008,016	4,349,574	6,357,590

[a] Includes Delaware, District of Columbia, Idaho, Montana, Nevada, North Dakota, South Dakota, Utah, and Wyoming.

Examination of the foregoing table will show that the rank of the various States varies according to whether the total number of springs reporting sales, the quantity of water sold, or the value of the sales (medicinal or table waters) is selected as the basis of comparison. The relative importance of the 10 leading States is given in the following table:

Rank of 10 leading States based on springs reporting, on quantity sold, and on value of output, 1910.

	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	Pennsylvania	Wisconsin	New York	Maine	Indiana.
4	California	Massachusetts	Virginia	Minnesota	Maine.
5	Virginia	Pennsylvania	California	California	California.
6	Wisconsin	Virginia	Texas	Massachusetts	Minnesota.
7	Texas	Louisiana	Wisconsin	Pennsylvania	Massachusetts.
8	Ohio	Ohio	Missouri	Louisiana	Pennsylvania.
9	Maine	California	Kansas	Virginia	New Hampshire.
10	Missouri	Colorado	West Virginia	New Jersey	Louisiana.

Minnesota, with total sales of 9,962,370 gallons of water, took first rank, while New York was a close second, with an aggregate of 8,780,903 gallons. However, the number of springs reporting from Minnesota was only 19, while the number from New York was 46.

Massachusetts led in the number of springs reporting, there being in all 55, but the sales from these springs was only 4,691,159 gallons, or a little more than half of what was sold from 46 springs in New York, and a little less than half the sales from 19 springs in Minnesota. Only three States, Minnesota, New York, and Wisconsin, reported sales of over 5,000,000 gallons of water in 1910, but Massachusetts, the next in rank, fell nearly 400,000 gallons below this figure. The aggregate sales of these four States amounted to 29,835,244 gallons, while the total sales from all States amounted to 62,030,125 gallons, or only a little more than twice as much. The number of springs reporting from the four States previously mentioned was 156, or somewhat less than one-fourth the total number reporting from all the States. Therefore, less than one-fourth of the springs supplied nearly one-half of all the water sold.

In considering the value of waters sold for their therapeutic effects, Indiana led, with sales amounting to $493,680; New Hampshire ranked second, with sales aggregating $184,817.

In comparing the incomes from the sale of table waters, Wisconsin led, with sales amounting to $885,983; New York was second, with $691,613; Maine was third, with $393,703; Minnesota fourth, with $276,424. In total value of waters sold, Wisconsin took first rank, the sales aggregating $974,366; New York was a close second, with $858,635; and Indiana a rather poor third, with $514,958. None of the other States reached the half-million-dollar mark, and few of them sold more than $250,000 worth of water. Wisconsin led in the aggregate value of water sold, because of the large demand for table waters from some of the principal springs. The importance of New York was also due in a great measure to the sale of table waters, but the income from the sale of medicinal waters was important. The prominence of Indiana depended almost entirely on the great demand for the medicinal waters, for the sales of table waters from that State are relatively unimportant.

CONDITION OF THE MINERAL WATER TRADE.

The sales of mineral waters in 1910 showed a net decrease from the preceding year of 2,644,361 gallons, and the reduction in value amounted to slightly more than one-half million dollars ($536,544). Probably this may be explained in part, if not wholly, by the fact that some springs previously reporting neglected to send statistics in time to have them incorporated in this report. The total number of delinquent springs was 55. The decrease in quantity of water sold exceeded 1,000,000 gallons from two States. The decrease was greatest from Minnesota, amounting to 3,783,772 gallons, but it was also large in Michigan, amounting to 1,306,584 gallons, and in Massachusetts, amounting to 732,923 gallons. Increase of sales in excess of 500,000 gallons was reported from Colorado, Connecticut, Louisiana, and Virginia. Nebraska, with sales of 12,785 gallons, showed an increase of 835.94 per cent; Connecticut, with sales of 1,608,775 gallons, had an increase of 132.72 per cent; and Oregon, with sales amounting to 88,970 gallons, had an increase of 116.47 per cent. Thus, while the sale of mineral waters from these States has been small, there was a rapid increase, and the industry is becoming important. This fact seems to indicate a more general demand for mineral waters and to foreshadow a broader development of the industry.

The tables which follow show the details of production, by States, for the last two years, and the increase or decrease in 1910 as compared with 1909.

Number of springs and quantity and value of mineral waters sold in 1909 and 1910.

State or Territory.	1909			1910		
	Springs reporting.	Quantity sold (gallons).	Value.	Springs reporting.	Quantity sold (gallons).	Value.
Alabama	10	116,645	$28,595	9	133,159	$30,639
Arkansas	10	1,213,742	153,163	10	1,065,676	89,772
California	44	2,179,187	444,230	41	2,008,697	394,841
Colorado	15	1,077,820	111,158	14	1,638,984	115,289
Connecticut	22	691,296	42,375	24	1,608,775	109,853
Delaware	1			1		
District of Columbia	2			2		
Florida	12	113,944	16,534	9	90,189	14,269
Georgia	13	782,166	99,888	11	734,135	63,171
Idaho	2			1		
Illinois	14	639,460	49,108	16	1,117,620	83,148
Indiana	18	663,815	446,249	15	754,111	514,958
Iowa	6	184,000	14,116	6	253,100	27,175
Kansas	19	633,024	89,796	17	591,004	82,307
Kentucky	16	756,425	73,767	12	403,736	55,195
Louisiana	5	1,375,000	103,850	4	2,313,000	163,975
Maine	33	1,515,541	402,593	29	1,238,171	404,539
Maryland	7	938,496	91,569	8	1,163,828	102,371
Massachusetts	60	5,424,082	228,067	55	4,691,159	241,949
Michigan	19	2,760,604	104,454	17	1,454,020	69,538
Minnesota	20	13,746,142	614,291	19	9,962,370	281,009
Mississippi	9	307,315	52,925	7	309,450	43,975
Missouri	28	765,032	111,448	27	657,035	96,488
Montana	2			2		
Nebraska	1			3	12,785	1,529
Nevada				1		
New Hampshire	10	934,072	245,607	10	706,828	202,831
New Jersey	11	1,419,500	127,025	11	1,583,050	133,139
New Mexico	6	157,700	28,839	5	171,600	30,160
New York	52	8,813,563	948,325	46	8,780,903	858,635
North Carolina	15	128,171	20,558	15	143,007	21,389
North Dakota	1			1		
Ohio	31	2,709,060	112,775	30	2,226,188	95,989
Oklahoma	12	563,475	35,194	4	115,000	4,950
Oregon	4	41,100	10,720	7	88,970	22,989
Pennsylvania	42	2,177,967	240,856	44	2,536,337	221,685
Rhode Island	9	502,970	35,438	8	528,725	34,703
South Carolina	15	372,880	95,885	15	410,691	78,465
South Dakota	3	17,220	2,161	2		
Tennessee	18	934,912	76,185	18	950,511	71,129
Texas	34	1,033,476	98,499	31	1,241,248	128,549
Utah	1			2		
Vermont	3	66,100	13,326	5	137,875	16,660
Virginia	49	1,504,530	203,455	40	2,441,923	301,523
Washington	7	39,260	15,958	4	31,200	12,571
West Virginia	13	233,349	64,730	13	336,444	81,742
Wisconsin	34	6,101,882	1,132,239	36	6,400,812	974,366
Wyoming	2			2		
States or Territories of one or two springs each, including those for which figures are not given in the above list		1,039,563	108,183		997,809	80,125
Total	760	64,674,486	6,894,134	709	62,030,125	6,357,590

Comparative production of mineral waters, 1909–10.

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.
Alabama	− 1	+ 16,514	+ 14.16	+ $2,044	+ 7.15
Arkansas	....	− 148,066	− 12.20	− 63,391	− 41.39
California	− 3	− 170,490	− 7.82	− 49,389	− 11.12
Colorado	− 1	+ 561,164	+ 52.07	+ 4,131	+ 3.72
Connecticut	+ 2	+ 917,479	+132.72	+ 67,478	+ 159.24
Florida	− 3	− 23,755	− 20.85	− 2,265	− 13.70
Georgia	− 2	− 48,031	− 6.14	− 36,717	− 36.76
Illinois	+ 2	+ 478,160	+ 74.78	+ 34,040	+ 69.32
Indiana	− 3	+ 90,296	+ 13.60	+ 68,709	+ 15.40
Iowa	....	+ 69,100	+ 37.56	+ 13,059	+ 92.51
Kansas	− 2	− 42,020	− 6.64	− 7,489	− 8.34
Kentucky	− 4	− 352,689	− 46.63	− 18,572	− 25.18
Louisiana	− 1	+ 938,000	+ 68.22	+ 60,125	+ 57.90
Maine	− 4	− 277,370	− 18.30	+ 1,946	+ .48
Maryland	+ 1	+ 225,332	+ 24.01	+ 10,802	+ 11.80
Massachusetts	− 5	− 732,923	− 13.51	+ 13,882	+ 6.09
Michigan	− 2	−1,306,584	− 47.33	− 34,916	− 33.43
Minnesota	− 1	−3,783,772	− 27.53	−333,282	− 54.25
Mississippi	− 2	+ 2,135	+ .69	− 8,950	− 16.91
Missouri	− 1	− 107,997	− 14.12	− 14,960	− 13.42
Nebraska	+ 2	+ 11,419	+835.94	+ 1,392	+1,016.06
New Hampshire	....	− 227,244	− 24.33	− 42,776	− 17.42
New Jersey	....	+ 163,550	+ 11.52	+ 6,114	+ 4.81
New Mexico	− 1	+ 13,900	+ 8.81	+ 1,321	+ 4.58
New York	− 6	− 32,660	− .37	− 89,690	− 9.46
North Carolina	....	+ 14,836	+ 11.58	+ 831	+ 4.04
Ohio	− 1	− 482,872	− 17.82	− 16,786	− 14.88
Oklahoma	− 8	− 448,475	− 79.59	− 30,244	− 85.94
Oregon	+ 3	+ 47,870	+116.47	+ 12,269	+ 114.45
Pennsylvania	+ 2	+ 358,370	+ 16.45	− 19,171	− 7.96
Rhode Island	− 1	+ 25,755	+ 5.12	− 735	− 2.07
South Carolina	....	+ 37,811	+ 10.14	− 17,420	− 18.17
Tennessee	....	+ 15,599	+ 1.67	− 5,056	− 6.64
Texas	− 3	+ 207,772	+ 20.10	+ 30,050	+ 30.51
Vermont	+ 2	+ 71,775	+108.58	+ 3,334	+ 25.02
Virginia	− 9	+ 937,393	+ 62.30	+ 98,068	+ 48.20
Washington	− 3	− 8,060	− 20.53	− 3,387	− 21.22
West Virginia	....	+ 103,095	+ 40.42	+ 17,012	+ 26.28
Wisconsin	+ 2	+ 298,930	+ 4.90	−157,873	− 13.94
Other States and Territories not included above	....	− 57,608	− 5.46	− 30,082	− 27.30
Net decrease, 1910	−51	−2,644,361	− 4.09	−536,544	− 7.78

TRADE PROSPECTS.

The mineral-water trade continues to be prosperous, the total sales, notwithstanding a considerable decrease, having had a value of $6,357,590 in 1910, and the future outlook is good. The demand for some classes of waters will naturally decline, and some of the older springs may gradually lose their patronage, but the total sales indicate that there is a large demand for pure drinking waters and waters having medicinal qualities that is being met in part by the enlargement of the facilities of some of the older springs and in part by the introduction of waters from new springs. The increase in wealth has probably influenced the consumption of table waters, especially of those that sell at high prices. The sale of table waters is also influenced by the concentration of population in large cities and the consequent danger of pollution of drinking waters. The development of new springs is frequently marked by a surprising growth of the sales. An income of a few hundred dollars one year may be followed by an income of several thousand the next year.

A great deal depends, however, on the ability and enterprise of the manager, for a demand must be created by skillful advertising, and the water must be delivered in such attractive form as to please the customers.

IMPORTS.

In 1910 the total imports, including natural, semiartificial, and strictly artificial waters, amounted to 3,306,303 gallons, valued at $983,136. 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. It will be noted that these figures are the lowest recorded since 1906, and are interesting as indicating the lessened demand during 1910 for foreign as well as for domestic mineral waters.

Mineral waters imported and entered for consumption in the United States, 1900, 1905–1910, in gallons.

Year.	Mineral waters.		Year.	Mineral waters.	
	Quantity.	Value.		Quantity.	Value.
1900	2,382,410	$663,803	1908	2,912,398	$1,033,047
1905	3,150,030	926,357	1909	3,464,524	1,085,177
1906	3,157,609	1,012,333	1910	3,306,303	983,136
1907	3,497,239	1,165,555			

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.

MINERAL-WATER TRADE BY STATES.

ALABAMA

According to the returns received from spring owners, the mineral-water trade of Alabama continued to prosper during 1910, sales increasing from 116,645 gallons reported during 1909 to 133,159 gallons in 1910, an increase of 16,514 gallons, or a little over 14 per cent. The value, however, owing to a decline of 2 cents per gallon in the average price for the year, increased only 7 per cent, or from $28,595 in 1909 to $30,639 in 1910. There were no new springs reporting during 1910, and one which sold a considerable quantity during 1909 changed ownership during the year and could not furnish data, thus decreasing the total number of springs from 10 to 9. About three-fourths of the total sales of mineral water in Alabama is used medicinally. There are resorts at 6 of the springs, accommodating more than 1,000 people, and the water at 3 is said to be used for bathing purposes. In addition to the quantity reported as sold, there were 10,500 gallons used for the manufacture of soft drinks.

The following list of 9 springs reported sales:

Bailey Springs, Florence, Lauderdale County.
Bromberg Gulf Coast Lithia Springs, 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 Springs, Spring Hill, Mobile County.
Magnolia Spring, Magnolia Springs, Baldwin County.
Matchless Mineral Wells, east of Greenville, Butler County.

ARKANSAS.

According to reports received from spring owners in Arkansas, there was a falling off in the volume of business for 1910, the total sales decreasing from 1,213,742 gallons, valued at $153,163, in 1909, to 1,065,676 gallons, valued at $89,772, in 1910, a decline of 12 per cent in quantity and of 41 per cent in value. The average price reported was 8 cents per gallon, against 13 cents as the average for 1909. The record for the last five years has been as follows:

Production and value of mineral waters in Arkansas, 1906–1910.

Year.	Springs reporting sales.	Quantity sold (gallons).	Value.	Year.	Springs reporting sales.	Quantity sold (gallons).	Value.
1906	8	727,765	$105,286	1909	10	1,213,742	$153,163
1907	7	431,511	85,236	1910	10	1,065,676	89,772
1908	10	1,175,053	212,835				

One new spring reported for the first time, the Blue Spring, the total number to report being 10, the same as for 1909. There were 3 springs in Arkansas which failed to report in 1910, and this may account in part for the apparent falling off in the trade. The larger proportion of the sales went for table use. There are resorts situated at 5 of the springs, and the water at 1 is said to be used for bathing. Besides the reported sales, there is a considerable quantity of water used in the manufacture of soft drinks.

The following 10 springs reported sales:

Arkansas Lithia Springs, near Hope, Hempstead County.
Arsenic Springs, Hot Springs, Garland County.
Blue Spring, Eureka Springs, Carroll County.
De Soto Springs, Hot Springs, Garland County.
Howard's Mineral Wells, Sharp, Independence County.
Mountain Blood Spring, near Hot Springs, Garland County.
Mountain Valley Spring, near Hot Springs, Garland County.
Ozarka Spring, Eureka Springs, Carroll County.
Rock Spring, Hot Springs, Garland County.
Siloam Spring, Siloam Springs, Benton County.

CALIFORNIA.

California's output of mineral waters during 1910 suffered a decline, the sales reported being 2,008,697 gallons, as compared with 2,179,187 gallons in 1909, a decrease of 170,490 gallons, or 8 per cent. The value also fell off $49,389, or 11 per cent, the average price of 20 cents per gallon remaining the same. The record for the last five years has been as follows:

Production and value of mineral waters in California, 1906–1910.

Year.	Springs reporting sales.	Quantity sold (gallons).	Value.	Year.	Springs reporting sales.	Quantity sold (gallons).	Value.
1906	28	1,487,975	$520,515	1909	44	2,179,187	$444,230
1907	28	1,680,169	460,972	1910	41	2,008,697	394,841
1908	40	1,960,770	393,920				

Three new springs were entered on the list, the Joseph Mountain, the Table Rock, and the Watters Springs, but several went out of business during the year, reducing the total number to 41. About one-third of the total output is used medicinally. Resorts are situated at 17 of the springs, with accommodations for more than 4,000 people, and the water at 15 springs is used for bathing. Exclusive of the sales reported, a large quantity of water was used in the manufacture of soft drinks.

The following 41 springs reported sales:

Adams Springs, Adams, Lake County.
Ætna Spring, Lidell, Napa County.
Alhambra Spring, near Martinez, Contra Costa County.
Allen Springs, Williams, Colusa County.
Arrowhead Spring, Arrowhead Springs, San Bernardino County.
Bartlett Spring, Bartlett Springs, Lake County.
Boyes Hot Spring, Sonoma, Sonoma County.
Buckman Lithia Springs, Descanso, San Diego County.
Bythnia Spring, Santa Barbara, Santa Barbara County.
California Geysers, The 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.
Duncan Springs, Hopland, Mendocino County.
El Granito Mineral Spring, El Cajon, San Diego County.
Elliotta White Sulphur Spring, Riverside, Riverside County.
Fouts Springs, Fouts Springs, Colusa County.
Joseph Mountain Spring, Corona, Riverside County.
Lepori Vichy Springs, near Napa City, Napa County.
Lytton Spring, Lytton, Sonoma 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.
Shasta Springs, Shasta Springs, Siskiyou County.
Spiers Spring, near Middletown, Lake County.
Table Rock Spring, Little Shasta, Siskiyou 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.
Valley Springs, Valley Springs, Calaveras County.
Veronica Medicinal Springs, near Santa Barbara, Santa Barbara County.
Vito Nuevo Spring, Mono County.
Watters Springs, Pope Valley, Napa County.
Witter Medical Springs, Witter, Lake County.

COLORADO.

There was a notable increase in the mineral-water sales of Colorado during 1910, the figures reported being 1,638,984 gallons, valued at $115,289, as compared with 1,077,820 gallons sold during 1909, valued at $111,158, a gain of 561,164 gallons or 52 per cent in quantity. There was but a slight increase in the total value, however, the average price per gallon falling from 10 to 7 cents. The following table gives the record for the State since 1906:

Production and value of mineral waters in Colorado, 1906–1910.

Year.	Springs reporting sales.	Quantity sold (gallons).	Value.
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
1910	14	1,638,984	115,289

No new springs reported during 1910 and one former producer was idle, the total number decreasing from 15 to 14. Only about one-sixth of the total sales is used medicinally. Resorts are situated at 3 of the springs, and the water at 4 is used for bathing. Exclusive of the sales of plain or carbonated water, there were 121,250 gallons used in the manufacture of soft drinks.

The 14 reporting springs are as follows:

Boulder Springs, Crisman, Boulder County.
Canon City Soda Spring, Canon City, Fremont County.
Clark Magnetic Mineral Spring, Pueblo, Pueblo County.
Columbia Well, Denver, Denver County.
Crystal Springs, Fowler, Otero County.
Deep Rock Artesian Well, Denver, Denver County.
Dr. Horn Mineral Springs, Colorado Springs, El Paso County.
Kearney Golden Spring, near Golden, Jefferson 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.

Connecticut is rapidly coming to the front as a producer of mineral water, and has passed the million-gallon mark, the sales having increased 133 per cent in 1910 over 1909. According to returns received, there were sold during the year 1,608,775 gallons, valued at $109,853, compared with 691,296 gallons sold in 1909, valued at $42,375, indicating a gain of 917,479 gallons, or 133 per cent, in quantity, and of $67,478, or 159 per cent in value. The average price per gallon was the same for the two years—6 cents. The record for the last five years is shown in the table which follows.

Production and value of mineral waters in Connecticut, 1906–1910.

Year.	Springs reporting sales.	Quantity sold (gallons).	Value.	Year.	Springs reporting sales.	Quantity sold (gallons).	Value.
1906	9	453,473	$76,827	1909	22	691,296	$42,375
1907	13	307,906	41,439	1910	24	1,608,775	109,853
1908	15	424,826	36,404				

Three new springs were added in 1910, the Berkshire, the Mystic, and the Oak Springs, bringing the total number of springs up to 24. Only a very small proportion of the total sales is used for medicinal purposes. There are no resorts at these springs, nor is the water at any used for bathing. An appreciable quantity was, however, used for the manufacture of soft drinks.

The names of the 24 reporting springs follow:

Ansantawae Spring, Milford, New Haven County.
Arethusa Spring, Seymour, New Haven County.
Berkshire Spring, Cornwall Bridge, Litchfield County.
Buttress Spring, Woodbridge, New Haven County.
Chalybeate Spring, Oxford, New Haven County.
Cherry Hill Spring, Highwood, New Haven County.
Crystal Spring, near Little River, Middlesex County.
Diamond Mineral Springs, Cheshire, New Haven County.
Granite Rock Spring, Higganum, Middlesex County.
Hermitage Spring, Monotowese, New Haven 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.
Mystic Spring, Old Mystic, New London County.
Nonquit Spring, Fairfield, Fairfield County.
Oak Spring, Middletown, Middlesex County.
Pequabuck Mountain Spring, Bristol, Hartford County.
Red Rock Spring, Meriden, New Haven County.
Rock Ledge Spring, Monotowese, New Haven County.
Stafford Mineral Springs, Stafford Springs, Tolland County.
Varuna Spring, North Stamford, Fairfield County.
Venture Rock Spring, Stonington, New London County.

DELAWARE.

In 1910, as in 1909, there was but one spring credited to Delaware. The water is sold chiefly in Wilmington for the table, although a considerable quantity was also used in the manufacture of soft drinks. The spring is:

Kiamensi Spring, near Wilmington, Newcastle County.

DISTRICT OF COLUMBIA.

There was a slight increase in the 1910 sales of mineral waters from the two springs credited to the District of Columbia. The water from both these springs is used entirely for the table, and is sold principally in Washington. The details of output have been included with other States having less than 3 reporting springs.

The 2 springs are as follows:

Gitche Crystal Spring, Benning.
Red Oak Spring, near Langdon.

FLORIDA.

Principally on account of the inactivity of three of Florida's springs, the total sales from that State show a marked decline during 1910, the output decreasing from 113,944 gallons in 1909 to 90,189 gallons in 1910, a loss of over 20 per cent. The average price reported was 16 cents per gallon, as compared with 15 cents per gallon reported in 1909. The total value showed a loss of about 14 per cent. There was 1 new spring reporting, the Newport Sulphur, the total number being 9, or 3 less than in 1909. Nearly all of the water sold was for table use. There are resorts at 4 of the springs, and the water at the same 4 is used for bathing. Besides the total reported sales, there were 10,000 gallons used for the manufacture of soft drinks.

The following 9 springs reported sales:

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.
Newport Sulphur Spring, Newport, Wakulla County.
Orange City Mineral Spring, Orange City, Volusia County.
Panacea Mineral Springs, Panacea, Wakulla County.
Wekiwa Springs, Wekiwa Springs, Orange County.

GEORGIA.

Returns from Georgia indicate a slight falling off in the trade during 1910, the sales decreasing from 782,166 gallons reported in 1909 to 734,135 gallons in 1910, a decline of 48,031 gallons, or 6 per cent. The value decreased in even greater ratio, from $99,888 to $63,171, a loss of $36,717, or 37 per cent. The average price reported was 9 cents per gallon, against 13 cents reported in 1909. One new spring reported for the first time, the Swift Lithia, but three others went out of business during the year, the total number reporting being 11, or 2 less than for 1909. The larger proportion of the sales is used medicinally. There are resorts at 4 of the springs, with total accommodations for more than 1,000 people, and the water at 1 is used for bathing.

The following is the list of the 11 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.
Miller's Spring, Milledgeville, Baldwin County.
Swift Lithia Spring, Elberton, Elbert County.
Utoy-Flora Spring, Utoy, Fulton County.
White Oak Mineral Spring, Macon, Bibb County.

IDAHO.

But one spring reported from Idaho during 1910, and the sales accordingly fell off to some extent. The water from this spring is used entirely for the table. The details of output are included with other States having less than three producing springs. The spring reporting is:

Idanha Spring, Soda Springs, Bannock County.

ILLINOIS.

According to the returns from spring owners of Illinois, there was marked prosperity in the trade during 1910, the sales exceeding the million-gallon mark for the first time. The output reported was 1,117,620 gallons, valued at $83,148, as compared with 639,460 gallons, valued at $49,108, in 1909, an increase of 478,160 gallons, or 75 per cent, in quantity and of $34,040, or 69 per cent, in value. The average price per gallon was reported as 7 cents, as compared with 8 cents reported in 1909. The record for the State since 1906 is as follows:

Production and value of mineral waters in Illinois, 1906–1910.

Year.	Springs reporting sales.	Quantity sold (gallons).	Value.	Year.	Springs reporting sales.	Quantity sold (gallons).	Value.
1906	15	574,453	$77,287	1909	14	639,460	$49,108
1907	15	720,400	91,760	1910	16	1,117,620	83,148
1908	17	685,763	58,904				

One new spring reported sales for the first time, the Lyons Mineral Well, and another resumed operations, the total number reporting being 16, or 2 more than in 1909. Practically all of the Illinois spring water is used for the table. There are resorts at 3 of the springs, accommodating about 300 people, and the water at 5 is used for bathing. Besides the quantity reported as sold, there were 45,400 gallons used in the manufacture of soft drinks.

The 16 reporting springs are as follows:

Abana Mineral Springs, Libertyville, Lake County.
Deerlick Mineral Spring, Deerfield, Lake County.
Diamond Mineral Springs, near Grantfork, Madison County.
Glen Flora Mineral Spring, Waukegan, Lake County.
Gravel Spring, near Jacksonville, Morgan County.
Greenup Mineral Spring, Greenup, Cumberland County.
Libertyville Crystal Spring, Libertyville, Lake County.
Lyons Mineral Well, Greenup, Cumberland County.
Macinac Mineral Spring, near Carlock, McLean County.
Mokena Mineral Spring, Mokena, Will County.
Montgomery Magnesia Spring, Montgomery, Kane County.
New Life Mineral Spring, near Ripley, Brown County.
Original Mineral Springs, Okawville, Washington County.
Peoria Mineral Springs, Peoria, Peoria County.
Sanicula Spring, Ottawa, Lasalle County.
White Diamond Spring, South Elgin, Kane County.

INDIANA.

In spite of the fact that 3 of the commercial springs of Indiana discontinued sales during 1910, the returns as reported from spring operators indicate a promising increase in output. Sales during that year amounted to 754,111 gallons, valued at $514,958. Compared with the 1909 returns of 663,815 gallons, valued at $446,249, these figures indicate a gain of 14 per cent in quantity and of 15 per cent in value. The average price for the year was 68 cents per gallon, one cent higher than for 1909. As noted in previous reports of this series, the comparatively high price per gallon for Indiana spring water is due to the large sales of French Lick water, which obtains a high price. There were no new springs added to the list for 1910, the total number reporting being 15, or 3 less than for 1909. More than 90 per cent of the total sales is used for medicinal purposes. There are 5 resorts situated at the springs, with total accommodations for more than 4,000 people, and the water at 8 is said to be used for bathing. In addition to the sales, there was a small quantity used in the manufacture of soft drinks.

The 15 reporting springs are as follows:

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.
Colomagna Springs, Columbus, Bartholomew County.
Hunter Mineral Springs, Kramer, Warren County.
King's Mineral Spring, Dallas, Clark County.
Knott's Mineral Spring, Porter, Porter County.
Mudlavia Lithia Spring, Kramer, Warren County.
Paoli Lithia Spring, Paoli, Orange County.
Pluto, Proserpine, and Bowles Springs, French Lick, Orange County.
Reid Mineral Spa Lithia Spring, near Richmond, Wayne County.
Vineland Spring, Terre Haute, Vigo County.
West Baden Mineral Springs, West Baden, Orange County.

IOWA

The mineral-water trade of Iowa recovered from the depression indicated in 1909 and nearly equaled the output of 1908. The sales reported during 1910 amounted to 253,100 gallons, valued at $27,175, an average price of 11 cents, as compared with 184,000 gallons, valued at $14,116, reported in 1909, a gain in quantity of 38 per cent and in value of 93 per cent, the average price for 1909 being 6 cents per gallon. There were no new springs reporting for the first time, the total number remaining the same—6. Practically the entire output was used for the table. There are no resorts at any of the Iowa springs, nor is the water at any used for bathing. A considerable quantity is, however, used for the manufacture of sweetened beverages.

The 6 reporting springs are as follows:

Colfax Mineral Wells, Colfax, Jasper County.
Council Bluffs Springs, Council Bluffs, Pottawattamie County.
Manawa Mineral Spring, Storm Lake, Buena Vista County.
Ottumwa Mineral Spring, Ottumwa, Wapello County.
Red Mineral Springs, Eddyville, Wapello County.
White Sulphur Spring, Davenport, Scott County.

KANSAS.

The record of the mineral-water trade of Kansas shows that in 1910 there were sold 591,004 gallons, with a total value of $82,307, as compared with 633,024 gallons sold the previous year, valued at $89,796, a decrease of 7 per cent in quantity and of 8 per cent in value. The average price remained the same for the two years—14 cents per gallon. No new springs reported, and 2 of the others were idle, thus reducing the total number of commercial springs in the State to 17. About two-thirds of the total production is sold for medicinal use. Resorts are situated at 6 of these springs, accomdating about 800 people, and the water at 9 is used for bathing.

In addition to the sales a large quantity was used for the manufacture of soft drinks.

The names of the 17 springs follow:

Abilena Spring, Abilene, Dickinson County.
Aganippe Spring, near Independence, Montgomery County.
Blasing's Natural Medical Spring, near Manhattan, Riley 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.

There was a decided falling off in the mineral-water trade of Kentucky during 1910, the sales decreasing from 756,425 gallons in 1909 to 403,736 gallons in 1910, a decline of 352,689 gallons, or 47 per cent. The value decreased also, though to a smaller extent, the average price per gallon rising from 10 to 14 cents. One new spring reported for the first time, the Craborchard, but several went out of business during the year, the total number reporting being 12, or 4 less than for 1909. About three-fifths of the total output is used medicinally. There are resorts at 3 of the springs, and the water at 1 is used for bathing. Exclusive of the total sales, a considerable quantity was reported as used in the manufacture of soft drinks.

The following 12 springs reported sales:

Anita Springs, La Grange, Oldham County.
Blue Lick Spring, Blue Lick Springs, Nicholas County.
Blue Rock Spring, Fisherville, Jefferson County.
Craborchard Springs, Crab Orchard, Lincoln County.
Drennon Springs, Drennon Springs, 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.
Robson Spring, Fort Thomas, Campbell County.
Royal Magnesian Spring, near La Grange, Oldham County.
Smith Medical Well, near Kelly, Christian County.
White's Epsom Spring, Crab Orchard, Lincoln County.

LOUISIANA.

The four commercial springs of Louisiana reported sales to the amount of 2,313,000 gallons during 1910, and the State takes seventh place among the producing States, the output being nearly as large as that reported from Virginia's 39 springs. The total sales, as compared with those reported for 1909, showed a gain of 938,000 gallons, or 68 per cent, in quantity and of $60,125, or 58 per cent, in value. The average price, however, declined from 8 to 7 cents per gallon. The record since 1908, in which year the totals were first published separately, is shown in the following table:

Production and value of mineral waters in Louisiana, 1908–1910.

Year.	Springs reporting sales.	Quantity sold (gallons).	Value.	Year.	Springs reporting sales.	Quantity sold (gallons).	Value.
1908	3	400,500	$52,020	1910	4	2,313,000	$163,975
1909	5	1,375,000	103,850				

No new springs reported during 1910, and one failed to make the usual report, the total number being thus reduced to 4. By far the greater portion of the water sold is used for drinking, principally in New Orleans. There are resorts at 2 of the springs accommodating about 3,000 people, and the water at 1 is said to be used for bathing. Exclusive of the total sales there was an appreciable quantity used in the manufacture of soft drinks.

The 4 reporting springs are as follows:

Abita Springs, Abita Springs, St. Tammany Parish.
Geyser Well, Hammond, Tangipahoa Parish.
Krotz Well, Krotz Springs, St. Landry Parish.
Ozone Spring, Pearl River, St. Tammany Parish.

MAINE.

On the face of the returns there was a falling off in the volume of trade in Maine during 1910, the sales decreasing 277,370 gallons, or 18 per cent, from 1,515,541 gallons in 1909 to 1,238,171 gallons in 1910. On account of the average price per gallon being 6 cents higher, however, the value increased slightly, from $402,593 in 1909 to $404,539 in 1910. The relatively high value of 33 cents reported as the average selling price of the water places Maine in fourth place among the States in value of output. The record for the last five years has been as follows:

Production and value of mineral waters in Maine, 1906–1910.

Year.	Springs reporting sales.	Quantity sold (gallons).	Value.	Year.	Springs reporting sales.	Quantity sold (gallons).	Value.
1906	28	1,368,113	$424,678	1909	33	1,515,541	$402,593
1907	26	1,161,832	414,300	1910	29	1,238,171	404,539
1908	27	1,182,322	394,346				

But one new spring reported during 1910, the Auburn Crystal, the total number reporting—29—being 4 less than for 1909. Only a relatively small proportion of the sales is used for medicinal purposes. Resorts are situated at 3 of the springs, with accommodations for about 700 people, and the water at 2 is used for bathing. A large quantity was also used for the manufacture of soft drinks.

The 29 reporting springs are as follows:

Auburn Crystal Spring, Auburn, Androscoggin County.
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 Mineral Spring, St. Albans, Somerset County.
Indian Hermit Spring, Wells, York County.
Keystone Mineral Spring, East Poland, Androscoggin County.
Mountain Purity Spring, Greene, Androscoggin County.
Mount Kebo Spring, Bar Harbor, Hancock County.
Mount Zircon Spring, Milton Plantation, Oxford 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.
Raymond Spring, North Raymond, Cumberland County.
Redman Farm Spring, Belfast, Waldo County.
Rocky Hill Spring, Fairfield, Somerset County.
Sabattus Mineral Spring, Sabattus, Androscoggin County.
Seal Rock Spring, Saco, York County.
Skowhegan Spring, Skowhegan, Somerset County.
Switzer Spring, Prospect, Waldo County.
Thorndike Mineral Spring, near Thorndike, Waldo County.
Ticonic Mineral Spring, Waterville, Kennebec County.
Underwood Spring, Falmouth Foreside, Cumberland County.
Virginia Spring, Rumford, Oxford County.
Wawa Lithia Spring, Ogunquit, York County.
Windmere Granite Spring, Windham, Cumberland County.

MARYLAND.

There was a decided gain in the mineral-water trade of Maryland during 1910, the sales passing the million-gallon mark for the first time since 1907. The reported output was 1,163,828 gallons, valued at $102,371, as compared with 938,496 gallons, valued at $91,569 in 1909, an increase of 225,332 gallons, or 24 per cent, in quantity, and of $10,802, or 12 per cent, in value. The average price per gallon reported for 1910 was 9 cents; that for 1909 was 10 cents. The record for the last five years has been as follows:

Production and value of mineral waters in Maryland, 1906–1910.

Year.	Springs reporting sales.	Quantity sold (gallons).	Value.	Year.	Springs reporting sales.	Quantity sold (gallons).	Value.
1906	5	593,671	$58,334	1909	7	938,496	$91,569
1907	7	1,023,562	110,039	1910	8	1,163,828	102,371
1908	8	806,673	75,858				

One new spring reported for the first time, the Gneiss Rock, the total number reporting being 8. The entire output is used for the table. There are resorts at 4 of the springs, with accommodations for 600 people, and the water at 2 is used for bathing. In addition to the sales a large quantity was reported as used in the manufacture of soft drinks.

The following 8 springs reported sales:

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.
Gneiss Rock Artesian Well, Ruxton Heights, Baltimore County.
Mardela Mineral Spring, Mardela, Wicomico County.
Spaws Spring, Easton, Talbot County.

MASSACHUSETTS.

The mineral-water trade of Massachusetts suffered a decline in 1910, the sales decreasing from 5,424,082 gallons in 1909 to 4,691,159 gallons in 1910, a decline of 732,923 gallons, or 14 per cent. The average price reported per gallon being 1 cent higher than in 1909, the total value increased from $228,067 in 1909 to $241,949 in 1910, a gain of $13,882, or 6 per cent. The record since 1906 is shown in the following table:

Production and value of mineral waters in Massachusetts, 1906–1910.

Year.	Springs reporting sales.	Quantity sold (gallons).	Value.	Year.	Springs reporting sales.	Quantity sold (gallons).	Value.
1906	53	3,857,955	$210,152	1909	60	5,424,082	$228,067
1907	51	4,661,115	208,579	1910	55	4,691,159	241,949
1908	61	4,395,049	227,907				

One new spring entered the list in 1910, the Oak Hill, but several former producers went out of business, the total number to report being 55, or 5 less than for 1909. In number of commercial springs Massachusetts leads all other States, but in total output ranks but fourth, and seventh in total value. Less than 10 per cent of the total sales is used medicinally. There is a resort at 1 of the springs, where the water is also used for bathing. Exclusive of the sales an appreciable quantity was used in the manufacture of soft drinks.

Following is the list of the 55 reporting springs:

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.
Deep Glen Spring, West Lynn, Essex County.
Diamond Spring, Lawrence, Essex County.
El-Azhar Spring, Lowell, Middlesex County.
Everett Crystal Spring, Everett, Middlesex County.
Farrington Silver Spring, Milton, 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.
King Philip Spring, Mattapoisett, Plymouth County.
Leland Spring, Natick, Middlesex County.
Los Altos Spring, Stoneham, Middlesex County.
Massasoit Spring, West Springfield, Hampden County.
Milton Spring, Milton, Norfolk County.
Mount Holyoke Lithia Spring, South Hadley, Hampshire County.
Mount Pleasant Spring, Lowell, Middlesex County.
Mount Vernon Spring, Lawrence, Essex County.
Nemasket Spring, Middleboro, Plymouth County.
Nobscot Mountain Spring, Framingham, Middlesex County.
Norwood Spring, Norwood, Norfolk County.

Oak Hill Spring, Brockton, Plymouth County.
October Spring, Lenox, Berkshire County.
Orient Spring, West Pelham, Hampshire County.
Pearl Hill Mineral Spring, Fitchburg, Worcester County.
Pepperell Spring, Pepperell, Middlesex County.
Pocahontas Spring, Lynnfield Center, Essex County.
Puritan Spring, Andover, Essex County.
Purity Spring, Spencer, Worcester 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.
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.

On the face of the returns there was a decided decline in the volume of trade in Michigan in 1910, owing to the fact that one of the larger springs failed to make returns. The total quantity reported as sold was 1,454,020 gallons, as compared with 2,760,604 gallons sold in the previous year, a decline of 1,306,584 gallons, or 47 per cent. The average price per gallon rose from 4 to 5 cents, so that the total value shows a loss of only 33 per cent, as compared with a loss in quantity of 47 per cent. The record for the last five years has been as follows:

Production and value of mineral waters in Michigan, 1906–1910.

Year.	Springs reporting sales.	Quantity sold (gallons).	Value.
1906	19	902,528	$73,357
1907	19	1,472,679	127,133
1908	24	2,004,433	88,910
1909	19	2,760,604	$104,454
1910	17	1,454,020	69,538

One new spring entered the list, the Maple Leaf, but several went out of business or were idle, the total number to report being 17, or 2 less than for 1909. Practically the entire output is used for the table. There are 5 resorts at these springs, accommodating more than 1,200 people, and the water at one is used for bathing. In addition to the total sales a considerable quantity was reported as used for the manufacture of soft drinks.

The list of 17 reporting springs follows:

Arctic Spring, Grand Rapids, Kent 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.
Maple Leaf Springs, Mount Clemens, Macomb 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.
St. Louis Magnetic Mineral Spring, St. Louis, Gratiot County.
Salutaris Spring, St. Clair, St. Clair County.
Sanitas Spring, Topinabee, Cheboygan County.
Sterling Spring, Crystal Falls, Iron County.
Victory Spring, Mount Clemens, Macomb County.
White Oak Spring, near Battle Creek, Calhoun County.

MINNESOTA.

Although there was a decided falling off in the volume of mineral-water trade in Minnesota during 1910, the State still holds first place in output. The sales amounted to 9,962,370 gallons, against 13,746,142 gallons reported in 1909, a decline of 3,783,772 gallons, or 28 per cent. The total value also declined from $614,291 to $281,009, a loss of $333,282, or 54 per cent, the average price being 3 cents in 1910 as compared with 4 cents reported in 1909. The record since 1906 is as follows:

Production and value of mineral waters in Minnesota, 1906–1910.

Year.	Springs reporting sales.	Quantity sold (gallons).	Value.	Year.	Springs reporting sales.	Quantity sold (gallons).	Value.
1906	7	8,621,979	$175,677	1909	20	13,746,142	$614,291
1907	8	9,654,030	524,800	1910	19	9,962,370	281,009
1908	11	10,985,536	551,986				

One of the commercial springs went out of business during 1910, and no new ones reported; otherwise the same springs selling in 1909 continued to do business in 1910. But little of the Minnesota water is used medicinally. There are no resorts at any of these springs, nor is the water at any used for bathing. There was, however, a large quantity reported as used in the manufacture of soft drinks. The 19 reporting springs are as follows:

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.
Indian Medical Spring, Elk River, Sherburne County.
Mankato 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.

There was a small decline in the mineral water sales of Mississippi during 1910, the output decreasing less than 1 per cent in quantity. Because of the lower price per gallon reported—14 cents, as compared with 17 cents reported in 1909—the total value decreased to the extent of 17 per cent. The sales reported for 1910 were 309,450 gallons, valued at $43,975, as compared with 307,315 gallons, valued at $52,925, in 1909. There were no new springs reporting in 1910, and 2 former active springs were temporarily out of business, thus reducing the total number reporting to 7. Practically all of the Mississippi spring water is used medicinally. Resorts are situated at 5 of the springs, accommodating about 700 people, and the water at 1 is used for bathing.

The names of the 7 reporting springs follow:

Arundel Lithia Spring, near Meridian, Lauderdale County.
Browns Wells, near Hazelhurst, Copiah County.
Castalian Spring, near Durant, Holmes County.
Mammoth Springs, Mammoth Springs, Forest County.
Robinson Springs, near Pocahontas, Hinds County.
Stafford Mineral Springs, Vosburg, Jasper County.
Vosburg Lithia Springs, Vosburg, Jasper County.

MISSOURI.

The record of the mineral-water trade in Missouri in 1910 showed a falling off in both quantity and value. The reported sales amounted to 657,035 gallons, valued at $96,488, as compared with 765,032 gallons, valued at $111,448, in 1909, a decline of 107,997 gallons, or 14 per cent, in quantity and of $14,960, or 13 per cent, in value. The average price per gallon for the 2 years remained the same—15 cents. There were no new springs heard from, and 1 failed to make reports, thus reducing the total number of commercial springs in the State to 27. There are resorts at 5 of the springs with accommodations for many thousands of people, it being stated that Excelsior Springs alone handles 10,000 people, and the water at 6 is used for bathing purposes. In addition to the sales an appreciable quantity was used in the manufacture of soft drinks.

The following 27 springs reported sales:

American Spring, St. Louis, St. Louis City County.
B. B. Springs, Bowling Green, Pike County.
Belcher Artesian Well, St. Louis, St. Louis City County.
Blue Lick Springs, Blue Lick, Saline County.
Bokert Springs, near De Soto, Jefferson 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.
Grand River Mineral Spring, near Mercer, Mercer 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.
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 Sea Well, Excelsior Springs, Clay County.
Salt Sulphur Well, Excelsior Springs, Clay County.
Sweet Springs, Sweet Springs, Saline County.

Thespian Spring, Louisiana, Pike County.
White Springs, Independence, Jackson County.
Windsor Spring, Windsor, Henry County.
Wyaconda Spring, Lagrange, Lewis County.

MONTANA.

Considerable increase was noted in the sales from the two commercial springs in Montana in 1910 as compared with 1909. The water at neither of these springs is used for medicinal purposes, and at one the greater part is used for bathing. The details of output are included with other States having less than 3 operating springs.

The 2 springs are:

Lissner's Mineral Spring, Helena, Lewis and Clark County.
Rock Creek Spring, Red Lodge, Carbon County.

NEBRASKA.

Owing to the inclusion of a new spring and the resumption of business of one of the older springs, the output of mineral water from Nebraska during 1910 showed a notable increase, and amounted to 12,785 gallons, valued at $1,529, an average price of 12 cents per gallon. The new spring to join the list was the Brown Park Spring, located at South Omaha. There is a resort at one of the springs, where the water is used also for bathing. Exclusive of the quantity sold, there were 84,282 gallons used in the manufacture of soft drinks.

The 3 reporting springs are as follows:

Brown Park Spring, South Omaha, Douglas County.
Curo Mineral Spring, South Omaha, Douglas County.
Shogo Lithia Springs, Milford, Seward County.

NEVADA.

Nevada entered the list of commercial springs for the first time in 1910. The output of the one spring is used for table purposes, and for the manufacture of soft drinks, and is the site of a resort where the water is used for bathing. The details of production are included with other States having less than 3 springs.

The name of the spring is:

Bower's Mansion Spring, Franktown, Washoe County.

NEW HAMPSHIRE.

Returns from New Hampshire indicate that the mineral-water trade suffered a decline both in quantity and in value. The reported sales amounted to 706,828 gallons, valued at $202,831, as compared with 934,072 gallons, valued at $245,607, reported in 1909, a decrease of 227,244 gallons, or 24 per cent in quantity, and of $42,776, or 17 per cent, in value. The average price per gallon rose from 26 to 29 cents. There were no new springs reported during 1910, the same number reporting as in 1909–10. By far the greater portion of the water sold is used medicinally; in fact, in this respect the State ranks second in value of medicinal waters, though in total output the rank is less than twentieth. There is a resort at one of the springs, but at none is the water used for bathing. Exclusive of the reported sales, more than 500,000 gallons went into the manufacture of soft drinks.

The 10 reporting springs are as follows:

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 Spring, Laconia, 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.

According to returns from New Jersey spring operators the mineral-water trade of that State continued to prosper during 1910, sales reaching a total of 1,583,050 gallons, valued at $133,139, as compared with 1,419,500 gallons in 1909, valued at $127,025, a gain of 163,550 gallons, or 12 per cent, in quantity, and of $6,114, or 5 per cent, in value. The average price per gallon declined from 9 to 8 cents. The record since 1906 has been as follows:

Production and value of mineral waters in New Jersey, 1906–1910.

Year.	Springs reporting sales.	Quantity sold (gallons).	Value.	Year.	Springs reporting sales.	Quantity sold (gallons).	Value.
1906	9	585,215	$65,186	1909	11	1,419,500	$127,025
1907	11	982,445	103,082	1910	11	1,583,050	133,139
1908	13	1,199,023	126,603				

No new springs reported during 1910, the total number being 11, the same as in 1909. Practically the entire output is used for table purposes. There are no resorts at any of the New Jersey commercial springs, nor is the water at any used for bathing. There was, however, a considerable quantity used in the manufacture of soft drinks.

The 11 reporting springs are as follows:

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.

New Mexico's output of mineral water during 1910 showed a further increase, indicating general prosperity in the trade. The figures reported for 1910 are 171,600 gallons sold, valued at $30,160, as compared with 157,700 gallons sold in 1909, valued at $28,839, a gain of 13,900 gallons, or 9 per cent, in quantity, and of $1,321, or 5 per cent, in value. The average price quoted of 18 cents per gallon was the same for both years. There were no new springs reporting, and 1 former producer failed to make returns, thus reducing the total number of commercial springs to 5. The output is about equally divided between medicinal waters and that used for the table. There is a resort at one of the springs where the water is also used for bathing, and a small quantity was reported as being used in the manufacture of soft drinks.

The 5 reporting springs are as follows:

Aztec Spring, Taylor, Colfax County.
Carlsbad Mineral Spring, Carlsbad, Eddy County.
Coyote Springs, Albuquerque, Bernalillo County.
Macbeth Spring, near East Las Vegas, San Miguel County.
Ojo Caliente Spring, Ojo Caliente, Taos County.

NEW YORK.

The mineral-water trade of New York during 1910 remained practically the same, the total sales showing a decrease of less than one-half of 1 per cent. The average price per gallon decreased 1 cent, from 11 to 10 cents, and the total value showed accordingly a decline of 9 per cent. The sales reported amounted to 8,780,903 gallons valued at $858,635, as compared with 8,813,563 gallons, valued at $948,325, in 1909. The record since 1906 has been as follows:

Production and value of mineral waters in New York, 1906–1910.

Year.	Springs reporting sales.	Quantity sold (gallons).	Value.	Year.	Springs reporting sales.	Quantity sold (gallons).	Value.
1906	42	6,481,074	$893,476	1909	52	8,813,563	$948,325
1907	41	7,176,815	686,574	1910	46	8,780,903	858,635
1908	47	8,007,092	855,148				

There were 5 new springs reporting for the first time, as follows: Arrowhead, Elk, Oak Mountain, Red Rock, and Valley Springs. Several discontinued sales, however, and a few declined to make returns, the total number to report being reduced by 6 to 46. In the relative rank of the different States New York holds second place in number of springs, total output, value of table water, and total value of sales, the total output being only a little more than 1,000,000 gallons less than that of the leading State, Minnesota. About three-fourths of the total sales is used for the table. There are resorts at 4 of the springs, but at none is the water used for bathing. Exclusive of the total sales, a considerable quantity was used for the manufacture of soft drinks.

The following springs reported sales:

Arrowhead Spring, Weedsport, Cayuga County.
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.
Chemung Spring, Chemung, Chemung County.
Chemung Valley Spring, Elmira, Chemung County.
Cold Springs, New York Mills, 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, Lancaster, Erie 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.
Mammoth Spring, North Greenbush, Rensselaer County.
Mount Beacon Spring, near Matteawan, Dutchess County.
Mount View Spring, Poughkeepsie, Dutchess County.
Oak Mountain Spring, near Dolgeville, Herkimer County.
Pleasant Valley Spring, Rheims, Steuben County.
Putnam Spring, near Peekskill, Westchester County.
Red Jacket Mineral Spring, Seneca Falls, Seneca County.
Red Rock Spring, Fine View, Jefferson County.
Saratoga Springs, Saratoga County:
- Arondack Spring.
- Congress Spring.
- Geyser Spring.
- High Rock Spring.
- Patterson Spring.
- Saratoga Carlsbad Spring.
- Saratoga Gurn Spring.
- Saratoga Seltzer 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.
Sun-Ray Spring, Ellenville, Ulster County.
Valley Spring, near Clayton, Jefferson County.
Vita Spring, Fort Edward, Washington County.
Washington Lithia Spring, Ballston Spa, Saratoga County.

NORTH CAROLINA.

According to returns received there was a substantial increase in the mineral-water trade of North Carolina during 1910, the sales reported being 143,007 gallons, as compared with 128,171 gallons in 1909, a gain of 14,836 gallons, or 12 per cent. The value also increased, though in less ratio, the average price per gallon declining from 16 to 15 cents. No new springs reported during the year, the total number to report being 15, the same as for 1909. The greater portion of the water sold is for medicinal use. Resorts are situated at 8 of the North Carolina springs, accommodating about 1,000 people, and the water at 4 is said to be used for bathing. A small quantity was also reported as used in the manufacture of soft drinks.

The following 15 springs reported sales:

All Healing Spring, Alkalithia Springs, Alexander County.
Barium Rock Spring, Barium Springs, Iredell County.
Buckhorn Lithia Spring, Bullock, Granville County.
Derita Mineral Spring, near Derita, Mecklenburg County.
Haywood White Sulphur Spring, Waynesville, Haywood County.
Huckleberry Spring, Durham, Durham County.
Jackson Springs, Jackson Springs, Moore County.
Mida Spring, near Huntersville, Mecklenburg County.
Moore's Springs, Moores Springs, Stokes County.
Mount Vernon Springs, Mount Vernon Springs, Chatham County.
Panacea Springs, Littleton, Halifax County.
Shelby Lithia Spring, Shelby, Cleveland County.
Sherrill Mineral Spring, near Harrisburg, Cabarrus County.
Smith Lithia Spring, Oxford, Granville County.
Vade Mecum Spring, Vade Mecum, Stokes County.

NORTH DAKOTA.

The same spring reported sales from North Dakota in 1910 as in 1909. The water at this spring is sold for table use, and a large quantity is also used in the manufacture of soft drinks. The details of output are included with other States having less than 3 operating springs. The name of the spring follows:

Gordon Spring, Michigan, Nelson County.

OHIO.

The mineral-water trade of Ohio showed a decline during 1910, the sales decreasing from 2,709,060 gallons in 1909 to 2,226,188 gallons in 1910, a loss of 482,872 gallons, or 18 per cent. The value also declined $16,786, or 15 per cent, from $112,775 in 1909 to $95,989 in 1910. The average price per gallon of 4 cents remained the same for the two years. The record for the State since 1906 has been as follows:

Production and value of mineral waters in Ohio, 1906-1910.

Year.	Springs reporting sales.	Quantity sold (gallons).	Value.	Year.	Springs reporting sales.	Quantity sold (gallons).	Value.
1906	27	1,790,767	$164,007	1909	31	2,709,060	$112,775
1907	24	1,536,621	121,531	1910	30	2,226,188	95,989
1908	27	2,409,598	124,938				

Two new springs reported for the first time during 1910, the Crystal and the Devonian Mineral, but 2 other springs went out of business and 1 was temporarily idle, so that the total number reporting was 30, or 1 less than in 1909. About one-fifth of the total sales were for medicinal use. There are resorts at 6 of the Ohio springs, with accommodations for approximately 400 people, and the water at 4 is said to be used for bathing. In addition to the quantity reported as sold there were 107,930 gallons used in the manufacture of soft drinks.

The list of reporting springs follows:

Beech Rock Spring, near Zanesville, Muskingum County.
Bellmore Springs, near Signal, Columbiana County.
Belmont Spring, Bridgeport, Belmont County.
Benson Lithia Spring, Bloom Township, Fairfield County.
Chalybeate Spring, Newark, Licking County.
Collingwood Springs, Toledo, Lucas County.
Crum Mineral Spring, Austintown, Mahoning County.
Crystal Spring, Newark, Licking County.
Crystal Fountain Springs, Plainville, Hamilton County.
Deerfield Spring, Deerfield, Portage County.
Devonian Mineral Spring, Lorain, Lorain County.
Fargo Mineral Spring, Ashtabula, Ashtabula County.
Highland Springs, Akron, Summit 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, Puritas, and Rockport Springs, West Park, Cuyahoga 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.
Spring Grove Lithia 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.

There seems to have been a serious decline in the mineral-water trade of Oklahoma during 1910, only 4 of the 12 commercial springs reporting sales. The total output for the year declined from 563,475 gallons, valued at $35,194 in 1909, to 115,000 gallons, valued at $4,950 in 1910, a loss of 80 per cent in quantity and of 86 per cent in value. The average price per gallon was 4 cents, as compared with 6 cents received in 1909. No new springs reported. About 80 per cent of the total sales is used medicinally. There is a resort at 1 of the springs, and the water at 2 is used for bathing purposes.

The names of the 4 reporting springs are as follows:

Bromide Well, Sulphur, Murray County.
Germicide Well, Wagoner, Wagoner County.
Kalium Spring, Faxon, Comanche County.
Lewis Crystalline Lithia Wells, Oklahoma City, Oklahoma County.

OREGON.

Returns from Oregon indicate a continued prosperity in the mineral-water trade in that State, the sales for 1910 increasing more than 100 per cent over those for 1909. The output amounted to 88,970 gallons, valued at $22,989, as compared with 41,100 gallons, valued at $12,269 sold in 1909, a gain of 47,870 gallons, or 116 per cent in quantity and of $12,269, or 114 per cent in value. The average price for the two years remained the same. There were 3 new springs credited to Oregon during the year, the Ashland Lithia Springs, the Sam-O, and the Selah, increasing the total number reporting to 7. Less than one-fourth of the total quantity sold is for medicinal use. There are resorts situated at 4 of these springs, with accommodations for nearly 200 people, and the water at 3 is used for bathing. In addition to the sales, there was a considerable quantity of spring water used in the manufacture of soft drinks.

The 7 reporting springs are as follows:

Ashland Lithia Springs, near Ashland, Jackson County.
Calapooya Spring, London, Lane County.
Cascade Mineral Spring, Cascadia, Linn County.
Colestin Spring, Colestin, Jackson County.
Sam-O Spring, Baker City, Baker County.
Selah Spring, Silverton, Marion County.
Siskiyou Spring, Soda Springs, Jackson County.

PENNSYLVANIA.

Pennsylvania continued to show a substantial increase in the mineral-water trade during 1910, there being more new springs credited to the State than to any other. The sales amounted to 2,536,337 gallons, valued at $221,685, as compared with 2,177,967 gallons in 1909, valued at $240,856, a gain of 358,370 gallons, or 16 per cent. The average price per gallon declined, however, from 11 cents reported in 1909 to 9 cents in 1910, and this caused a decrease of about 8 per cent in the total value of the output. The record for the State since 1906 has been as follows:

Production and value of mineral waters in Pennsylvania, 1906–1910.

Year.	Springs reporting sales.	Quantity sold (gallons).	Value.	Year.	Springs reporting sales.	Quantity sold (gallons).	Value.
1906	27	1,506,286	$280,054	1909	42	2,177,967	$240,856
1907	28	1,287,063	235,807	1910	44	2,536,337	221,685
1908	32	1,430,489	180,889				

Six new springs reported for the first time, as follows: Blue Ridge, Chadwick, Glenn Crystal, Puritas, Springfield, and Sylvia White Sand springs, which increased the total number of commercial springs to 44. The greater part of the output is used for the table. Resorts are situated at 12 of the springs, with total accommodations for about 5,000 people, and the water at 5 is used for bathing. More than 400,000 gallons were reported as used for the manufacture of soft drinks.

The following 44 springs reported sales:

Bedford Mineral Spring, near Bedford, Bedford County.
Blue Ridge Spring, Bangor, Northampton County.
Brookside Spring, Wilkinsburg, Allegheny County.
Bruce Subrock Spring, Pittsburgh, Allegheny County.
Carnegie Alkaline and Lithia Mineral Spring, Carnegie, Allegheny County.
Chadwick Spring, Cambridge Springs, Crawford County.
Cloverdale Lithia Spring, near Newville, Cumberland County.
Cold Spring, Lotell, Lebanon County.
Colvin White Sulphur Spring, Sulphur Springs, Bedford 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 Brook, Lawrence County.
Glenn Crystal Spring, Harbor Creek, Erie 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.
Lang Spring, Venango, Crawford County.
Massassauga Mineral Spring, Erie, Erie County.
Mount Laurel Spring, Temple, Berks County.
Mount Royal Springs, Shaler Township, Allegheny County.
Original Magnesia Springs, Cambridge Springs, Crawford 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.
Puritas Spring, near Erie, Erie County.
Ross Common Spring, Ross Common, Monroe County.
Seely Spring, Beach Haven, Luzerne County.
Sizerville Mineral Spring, Sizerville, Cameron County.
Springfield Spring, Springfield Township, Delaware County.
Spruce Hollow Spring, near Northumberland, Northumberland County.
Sylvia White Sand Spring, near Seward, Westmoreland 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.

RHODE ISLAND.

In spite of the fact that one of the former large producers of mineral water in Rhode Island declined to make returns for 1910, the output increased. The total sales during the year amounted to 528,725 gallons, valued at $34,703, as compared with 502,970 gallons, valued at $35,438, in 1909. The gain in quantity amounted to 5 per cent. The average price per gallon for the two years was the same—7 cents. No new springs reported, the total number being 8. All of the mineral water sold in this State is for table use. There are no resorts at any of the springs, nor is the water at any used for bathing.

The following is the list of reporting springs:

Banner Spring, 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.
Holley Mineral Spring, East Woonsocket, Providence County.
Ochee Spring, Johnston, Providence County.
Prophet Spring, near Providence, Providence County.

SOUTH CAROLINA.

South Carolina was one of the few States to show an increase in the mineral-water trade during 1910, the sales increasing from 372,880 gallons reported in 1909 to 410,691 gallons in 1910, a gain in quantity of 37,811 gallons, or 10 per cent. The value, however, decreased considerably, the average price reported being 19 cents, as compared with 26 cents reported in 1909. This falling off in value is accounted for in part by the fact that one of the largest springs changed hands during the year, and the proprietors sold the water at a lower price. There was 1 new spring to enter the lists, the Clementia, but 1 other declined to make returns, so that the total number to report was 15, the same as for 1909. About three-fourths of the total output is used medicinally. There are resorts at 6 of the springs, accommodating more than 1,000 people, and the water at 3 is said to be used for bathing. In addition to the sales reported there was a considerable quantity used in the manufacture of soft drinks.

The following 15 springs reported sales:

Antley Springs, St. Matthews, Calhoun County.
Bryan Springs, Young Island, Colleton County.
Charleston Artesian Well, Charleston, Charleston County.
Chick Springs, Chick Springs, Greenville County.
Clementia Spring, near Meggett, Colleton 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.
Piedmont Spring, Kings Creek, Cherokee County.
Rives Mineral Spring, near Lancaster, Lancaster County.
Steele Mineral Spring, Rock Hill, York County.
Verner Spring, Greenville, Greenville County.
White Diamond Lithia Spring, Kings Creek, Cherokee County.
White Stone Spring, White Stone Springs, Spartanburg County.

SOUTH DAKOTA.

One of the commercial springs of South Dakota sold no spring water during 1910, and the output of the other 2 springs has been included with other States having less than 3 operating springs. The output decreased slightly. There is a resort at one of the springs where the water is also used for bathing, and at the other the water is used principally in giving baths. A large quantity is also used for the manufacture of soft drinks.

The 2 reporting springs are as follows:

Minnehaha Springs, Sioux Falls, Minnehaha County.
Siloam Mineral Spring, Hot Springs, Fall River County.

TENNESSEE.

The mineral-water trade of Tennessee remained practically the same in 1910 as in 1909, the sales increasing from 934,912 gallons sold in 1909 to 950,511 gallons sold in 1910, a gain of 15,599 gallons, or 2 per cent. Owing to the fact that the average price declined from 8 to 7 cents per gallon, the total value of the output decreased from $76,185 in 1909 to $71,129 in 1910, a loss of $5,056, or 7 per cent. One new spring was added to the list, the Mineral Park Spring, but 1 other former spring went out of business, so that the total number reporting remained the same as in 1909—18. Only about one-seventh of the total output from the State is used for the table, the Tennessee waters having a wide medicinal reputation. Resorts are situated at 11 of the springs with accommodations for nearly 2,000 people, and the water at 6 is used for bathing.

The 18 reporting springs are as follows:

East Brook Springs, Eastbrook, Franklin County.
Galbraith Epsom Lithia Springs, Galbraith Springs, Hawkins County.
Gammons Spring, near Tate Spring, Grainger County.
Gladstone Spring, near Chattanooga, Hamilton County.
Hamilton Springs, near Lebanon, Wilson County.
Horn Springs, Horn Springs, Wilson County.
Idaho Springs, near Clarksville, Montgomery County.
Mineral Park Springs, McDonald, Bradley 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.

Although there was a general falling off in the number of commercial springs in Texas, the output increased appreciably, indicating continued prosperity in the trade. The sales during 1910 amounted to 1,241,248 gallons, against 1,033,476 gallons reported in 1909, a gain of 207,772 gallons, or 20 per cent. The value increased from $98,499 to $128,549, a gain of 31 per cent. The average price per gallon was 10 cents, the same as for 1909. The record for the State since 1906 has been as follows:

Production and value of mineral waters in Texas, 1906–1910.

Year.	Springs reporting sales.	Quantity sold (gallons).	Value.	Year.	Springs reporting sales.	Quantity sold (gallons).	Value.
1906	28	1,045,315	$122,085	1909	34	1,033,476	$98,499
1907	23	1,146,279	152,233	1910	31	1,241,248	128,549
1908	36	1,586,634	151,032				

Two new springs joined the list in 1910, the Mangum and the Maurice wells, but several were idle or out of business, the total number to report being 31, or 3 less than in 1909. About three-fourths of the total sales in Texas is used medicinally. Resorts are situated at 15 of the springs, with total accommodations for about 10,000 people, and the water at 13 is said to be used for bathing. In addition to the sales, there was a considerable quantity of spring water used in the manufacture of soft drinks.

The following is the list of the reporting springs:

Aqua Vitae Wells, Nacogdoches, Nacogdoches County.
Blossom Mineral Wells, Blossom, Lamar County.
Brock's Mineral Well, near Denton, Denton County.
Burdette Well, near Lockhart, Caldwell County.
Capp's Wells, Longview, Gregg County.
Eureka No. 2 Well, East 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.
Lonestar Mineral Well, near Texarkana, Bowie County.
Mangum Wells, Mangum, Eastland County.
Marlin Hot Wells, Marlin, Falls County.
Maurice Wells, Mangum, Eastland County.
Mineral Wells, Palo Pinto County:
  Austin Well.
  Crazy Well.
  Crystal Well.
  Gibson Well.
  Lamar Well.
  Palo Pinto and Texas Carlsbad Wells.
  Standard Wells.
  Star 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.
Sour Wells, Sulphur Springs, Hopkins County.

UTAH.

The addition of a new spring to the list for Utah made considerable increase in the output for 1910, the details of which are included with other States having less than 3 operating springs. Neither of the 2 springs credited to the State is used as a resort. Their names are as follows:

Deseret Lithia Spring, Deseret, Millard County.
Utanah Springs, Wasatch Mountains.

VERMONT.

Owing to resumption of business in 1910 on the part of two of Vermont's commercial springs, the output increased from 66,100 gallons reported in 1909 to 137,875 gallons in 1910, an increase of 71,775 gallons, or 109 per cent. On account of a fall in the average price per gallon, however, the total value increased only 25 per cent. About one-fifth of the total water sold is for medicinal use. No new springs reported during the year. There are resorts at 2 of the 5 springs, with accommodations for about 400 people, and the water at one is said to be used for bathing. Exclusive of the sales, there was a considerable quantity of water made up into soft drinks.

The 5 springs to report are as follows:

Brunswick Sulphur Springs, Brunswick, Essex County.
Clarendon Spring, Clarendon Springs, Rutland County.
Equinox Spring, Manchester, Bennington County.
Missisquoi Spring, Sheldon Junction, Franklin County.
Vermont Cold Spring, Rutland County.

VIRGINIA.

Although the number of commercial springs reporting from Virginia in 1910 was 9 less than for 1909, the total sales show a substantial increase. According to returns received, there were sold during the year 2,441,923 gallons, valued at $301,523, as compared with 1,504,530 gallons, valued at $203,455, in 1909, an increase of 937,393 gallons, or 62 per cent, in quantity and of $98,068, or 48 per cent, in value. The average price per gallon declined from 14 to 13 cents. The record since 1906 has been as follows:

Production and value of mineral waters in Virginia, 1906–1910.

Year.	Springs reporting sales.	Quantity sold (gallons).	Value.	Year.	Springs reporting sales.	Quantity sold (gallons).	Value.
1906	43	1,997,207	$418,908	1909	49	1,504,530	$203,455
1907	44	2,442,075	431,770	1910	40	2,441,923	301,523
1908	46	2,009,614	207,115				

Two new springs were added to the list, the Pickett and the Quick Springs, the total number reporting being 40. The total output is about equally divided between medicinal and table waters. Virginia holds fifth place in number of springs, and sixth place in both quantity and value of water sold. There are resorts at 13 of the springs, accommodating about 2,000 people, and the water at 7 is used for bathing. In addition to the sales, a small quantity was used in the manufacture of soft drinks.

The following 40 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.
Blue Ridge Springs, near Blue Ridge Springs, Botetourt County.
Buckhead Lithia Spring, Buckhead Springs, Chesterfield County.
Buffalo Lithia Spring, Buffalo Lithia Springs, Mecklenburg County.
Burnetts Spring, Hudson Mill, Culpeper County.
Campfield Lithia Spring, Chesterfield County.
Carper Lithia Springs, Radford, Montgomery 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.
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.
Mecklenburg Spring, Chase City, Mecklenburg County.
Nye Lithia Springs, Wytheville, Wythe County.
Otterburn Lithia Spring, near Amelia, Amelia County.
Paeonian Spring, Paeonian Springs, Loudoun County.
Pickett Spring, Worsham, Prince Edward County.
Quick Spring, near Staunton, Augusta County.
Rockbridge Alum Springs, Rockbridge Alum Springs, Rockbridge County.
Rubino Healing Springs, Healing Springs, Bath County.
Seawright Spring, near Staunton, Augusta County.
Stribling Springs, Stribling Springs, Augusta County.
Tripho-Lithia Spring, Claremont, Surry County.
Virginia Etna Springs, Vinton, Roanoke County.
Virginia Magnesian Alkaline Spring, near Staunton, Augusta County.
Wallawhatoola Springs, Millboro, Bath County.
Wyrick Mineral Spring, Crockett, Wythe County.

WASHINGTON.

Three springs which reported sales from Washington during 1909 did not market any water during 1910, and principally on account of this fact, the total output from the State decreased from 39,260 gallons to 31,200 gallons, a decline of 21 per cent. The total value also decreased to $12,571, a falling off of 21 per cent. The average price per gallon reported was 40 cents, as compared with 41 cents for 1909. No new springs reported, the total number being 4, or 3 less than for 1909. There is a resort at one of the springs, and the water at another is used for bathing.

The 4 reporting springs are as follows:

Diamond Mineral Spring, Auburn, King County.
Olympia Hygeian Spring, Tumwater, Thurston County.
Sahala Spring, Medical Lake, Spokane County.
Soda Spring, North Yakima, Yakima County.

WEST VIRGINIA.

The mineral-water trade of West Virginia continued to show prosperity, the sales in 1910 amounting to 336,444 gallons, as compared with 233,349 gallons in 1909, a gain of 40 per cent. The value also increased from $64,730 to $81,742, an increase of 26 per cent. The average price per gallon showed a further decline, from 28 to 24 cents. One new spring reported for the first time, the Crystal, but another went out of business, the total number to report being 13, the same as for 1909. The greater part of the output is used medicinally, which accounts in part for the relatively high price per gallon received for the water. There are resorts at 8 of the springs, accommodating nearly 3,000 people, and the water at 5 is used for bathing also. In addition to the sales, a small quantity was reported as used in the manufacture of soft drinks by the spring owners.

The list of the 13 reporting springs is as follows:

Barilithic Spring, Webster Springs, Webster County.
Borland Mineral Springs, Borland, Wood County.
Carney Sulphur Spring, Valley Heights, Summers County.
Crystal Springs, Springdale, Parkersburg, Wood County.

Greenbrier Alum Spring, Maxwelton, Greenbrier County.
Green Sulphur Spring, Green Sulphur Springs, Summers County.
Man-A-Cea Irondale Spring, Independence, Preston County.
Pence Spring, Pence Springs, Summers County.
Saline-Chalybeate and Vigoro Spring, Woodsdale, Ohio County.
Walnut Hill Spring, near Charleston, Kanawha County.
Webster Springs, Webster Springs, Webster County.
White Sulphur Springs, White Sulphur Springs, Greenbrier County.

WISCONSIN.

Wisconsin continued to show a small increase in output of mineral waters, though the value thereof decreased considerably. The sales reported amounted to 6,400,812 gallons, valued at $974,366, as compared with 6,101,882 gallons reported the previous year, valued at $1,132,239, an increase of 5 per cent in quantity, but a decrease of 14 per cent in value, the average price for the year being 15 cents, as against 19 cents received in 1909. In spite of the decline in value, however, Wisconsin still leads all the other States in the total value of sales. The record since 1906 has been as follows:

Production and value of mineral waters in Wisconsin, 1906-1910.

Year.	Springs reporting sales.	Quantity sold (gallons).	Value.	Year.	Springs reporting sales.	Quantity sold (gallons).	Value.
1906	27	7,702,718	$2,397,694	1909	34	6,101,882	$1,132,239
1907	29	6,839,219	1,526,703	1910	36	6,400,812	974,366
1908	28	6,084,571	1,239,907				

Four new springs entered the list for the first time, the Arbutus Mineral, the Crystal, the Elysian, and the Fontana Lithia, the total number to report being 36. In number of commercial springs Wisconsin ranks sixth among the States, as compared with third place in quantity of water sold, and first place in value. The greater part of the output is for table use. There are resorts at only 2 of the springs, and the water at 1 is used for bathing. In addition to the sales, more than 2,000,000 gallons was reported as used in the manufacture of soft drinks.

Following is the list of the 36 reporting springs:

Allouez Spring, Green Bay, Brown County.
Alta Spring, Dunfield, Lincoln County.
Arbutus Mineral Spring, Oconto, Oconto County.
Bay City Spring, Ashland, Ashland County.
Bethania Spring, Osceola, Polk County.
Bryant Silver Spring, Madison, Dane County.
Chippewa Spring, Chippewa Falls, Chippewa County.
Crystal Spring, Sheboygan, Sheboygan County.
Darlington Mineral Spring, Darlington, Lafayette County.
Elim Mineral Spring, Wauwatosa, Milwaukee County.
Elysian Spring, Prairie du Chien, Crawford County.
Fontana Lithia Spring, Fontana, Walworth County.
Hiawatha Springs, Janesville, Rock County.
Kusche Spring, Oshkosh, Winnebago County.
Lebenswasser Spring, Green Bay, Brown County.
Maribel Mineral Spring, Maribel, Manitowoc 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.
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.

WYOMING.

Returns from the 2 springs in Wyoming indicate a thriving business. Both of these springs are used as resorts, where the water is used for bathing, and at 1 a considerable quantity is used for the manufacture of soft drinks.

The 2 springs to report are as follows:

DeMaris Spring, Cody, Bighorn County.
Saratoga Hot Springs, Saratoga, Carbon County.

MONAZITE.

By Douglas B. Sterrett.

INTRODUCTION.

Monazite is a phosphate of cerium, lanthanum, and other rare metals containing a percentage of thoria (ThO_2=thorium oxide) ranging from less than 1 per cent to more than 20 per cent. The quantity contained in monazite that is used as a commercial source of thoria is generally over 3 per cent. The supply of thoria is obtained chiefly from monazite, though other minerals that contain a higher percentage of thoria have been used when obtained in sufficient quantity.

Monazite is in demand chiefly for making mantles for incandescent gas lights, which are composed largely of thoria combined with small quantities of other oxides of rare earths. The discovery by Auer von Welsbach that alloys of iron with cerium, lanthanum, and other rare earth metals contained in monazite will emit brilliant sparks when scratched by a file has been put to practical use. Several forms of gas and gasoline lamp lighters have been made from these alloys. One form, in which a ratchet wheel revolves against a rod of the alloy and casts bright sparks against a wick of a gasoline lamp, is now used to replace matches.

Monazite is subtransparent to translucent to opaque and ranges in color from grayish to yellow, to reddish, to brownish, and some of it is greenish. The luster is especially brilliant on the cleavage faces. Its specific gravity ranges from 4.9 to 5.3 and is generally over 5. It is brittle and has a hardness of 5 to 5.5. Small grains of monazite may readily be crushed between the teeth as a rough test to distinguish it from harder minerals of similar color, such as iron-stained quartz, epidote, and staurolite.

Monazite occurs in small crystals and grains as an accessory mineral of the granites and gneissic rocks of some regions. In a few localities it is a constituent of pegmatite, occurring in crystals and masses whose weight is measured by pounds. By the disintegration of monazite-bearing rock the monazite is set free and, being heavier than the rock in which it was inclosed, is concentrated along rivers and creeks in gravel deposits, from which the supply of monazite for commercial purposes is obtained in the form of sand.

For many years the world's supply of monazite has come from Brazil and the United States. The Brazilian monazite comes from beach deposits on the coast, where it has been naturally concentrated by wave action, and from placer deposits in the river valleys in the interior. The monazite used for commercial purposes in the United States has come from North Carolina and South Carolina, but important undeveloped deposits have been found in Idaho and other States. The monazite deposits of the Carolinas have been described by Nitze,[1] Pratt,[2] and Sterrett.[3]

Deposits near Centerville, Boise County, Idaho, have been described by Waldemar Lindgren;[4] other deposits, in Nez Perce County, Idaho, have been described by F. C. Schrader.[5]

The extension into Montana of the monazite deposits associated with the immense granite areas of Idaho and Montana is suggested by the discovery of monazite in the gravels of Trail Creek, or the north fork of the Big Hole River, in Beaverhead County. Samples of monazite sand from this region that had been cleaned to probably about 65 per cent monazite were received by the Geological Survey from Mr. Edward Hoffenbrodel, of Butte, Mont., and subjected to a partial analysis by Dr. Chase Palmer of the Survey. The analysis showed the presence of about 1.69 per cent of thoria, equivalent to about 2.6 per cent of thoria in the pure monazite. Monazite has been found on several tributaries of Trail Creek, heading along the Montana-Idaho State line about 10 miles from Gibbonsville, Idaho, and in the Big Hole National Forest. Mr. Hoffenbrodel states that the gravel contains from one-quarter to 1 pound of monazite per cubic yard and can be handled at a cost of about 4 to 5 cents per cubic yard.

PRODUCTION.

The production of crude monazite sand in the United States in 1910 amounted to 354,224 pounds, averaging about 25 per cent monazite. The crude concentrates yielded 99,301 pounds of refined sand, whose value before cleaning was $12,006. Nearly 85 per cent of the production came from North Carolina and the remainder from South Carolina. The miners were paid a little more than 12 cents a pound for the refined monazite obtained from the crude sand delivered to the cleaning mills, or about 3½ cents a pound for the crude monazite.

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, 1909, and 1910:

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[1] Nitze, H. B. C., Monazite and monazite deposits in North Carolina: Bull. North Carolina Geol. Survey No. 9, 1895.

[2] Pratt, J. H., and Sterrett, D. B., Monazite and monazite mining in the Carolinas: Trans. Am. Inst. Min. Eng., vol. 40, 1909, pp. 483–511.

[3] Sterrett, D. B., Monazite and zircon: Mineral Resources for 1906, U. S. Geol. Survey, 1907, pp. 1195–1209.

[4] Monazite and zircon: Mineral Resources U. S. for 1909, U. S. Geol. Survey, 1911.

[5] An occurrence of monazite in northern Idaho: Bull. U. S. Geol. Survey No. 430, pp. 184–191.

Production, in pounds, of monazite in the United States, 1893–1910.

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	1910	99,301	12,006

[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 Centerville Mining & Milling Co., of Centerville, Idaho, which had erected a well-equipped mill and installed improved electromagnetic cleaning machinery, made no production, for its plant was destroyed by forest fires in August, 1910. The showing made during the preliminary work was so favorable that the officers of the company express the determination to rebuild the plant.

The production of refined monazite in the United States in 1910 was less by 442,630 pounds in quantity and $53,026 in value than in 1909, a decrease in output of about 82 per cent.

IMPORTS.

According to the Bureau of Statistics of the Department of Commerce and Labor, 453,554 pounds of monazite, valued at $39,699, and 5,234 pounds of thorium oxide, valued at $8,500, were imported into the United States in 1910. The quantity of thorium nitrate imported in 1910 was the largest yet recorded, exceeding that of 1909 by 49,223 pounds. The value of the imports in 1910, however, was less by $17,344 than in 1909. The imports of 1910 and the preceding seven years are shown in the following table:

Imports, in pounds, of thorium nitrate into United States, 1903–1910.

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	1910	124,808	219,615

The price per pound in foreign markets as deduced from this table was only $1.23½, as against $1.85 in 1909 and $2.65 in 1908. The imports of thorium oxide in 1910 were less by 12,315 pounds in quantity and $11,096 in value than the imports of thorium oxide and other salts, not nitrate, in 1909.

The large imports of monazite and manufactured thorium salts have caused the closing down of practically all the monazite mines in North Carolina and South Carolina. The decrease in the domestic production of monazite in 1910 as compared with 1909 was nearly balanced by the increase in imports, showing that the manufacture of thorium salts in the United States has not yet been materially reduced and that the demand for thorium products continues as strong if not stronger than ever. It is not likely that the monazite deposits of the Carolinas will be operated in more than a desultory way while the price of thorium nitrate is kept so low by the German and Austrian manufacturers. The present rate of duty (4 cents per pound) on monazite imported into the United States has opened a large market for foreign monazite. The imported monazite is valued at 8.7 cents per pound; the 4 cents duty raises its price to 12.7 cents per pound. The price (12 cents per pound) paid to domestic miners for monazite does not include the expense of refining by electromagnetic machinery.

QUARTZ AND FELDSPAR.

By Edson S. Bastin.

QUARTZ.

INTRODUCTION.

Quartz, the most abundant of all minerals, occurs in a great variety of forms and is utilized commercially in many different ways. Certain transparent colored varieties, such as rose and smoky quartz and amethystine quartz, have a gem value and are discussed in the chapter on precious stones. Sand used for building, molding, and in glass and pottery manufacture, is also discussed in other parts of this volume, as are tripoli and sandstone and quartzite used for building purposes, although all these materials are nearly pure quartz. This chapter deals only with massive crystalline quartz (often called vein quartz), with flint, and with quartzite which is used for other than building or paving purposes.

MASSIVE CRYSTALLINE QUARTZ.

Quartz of this variety is usually white, though occasionally rose-colored or smoky. It occurs in veins or dikelike masses, unmixed with other minerals, or as a constituent of pegmatite. In the latter occurrence it is usually produced as an accessory in the mining of feldspar. The States producing massive crystalline (vein) quartz in commercial quantity in 1910 were Connecticut, Maryland, New York, Pennsylvania, Wisconsin, Tennessee, Michigan, and Arizona. Small quantities were formerly marketed from Maine, but these quarries are so far from the principal markets that the quartz can not now be sold at a profit.

QUARTZITE.

This rock may be described as a sandstone in which the spaces between the quartz grains have been completely or almost completely filled, either through a further deposition of quartz between the grains or through a recrystallization of the quartz of the original grains. The result is a solid mass of quartz. In Tennessee a hard, vitreous quartzite of Cambrian age is extensively quarried for use as a flux in copper smelting.

FLINT.

The name flint is properly applied only to quartz of exceedingly compact texture, dull surface, and perfectly conchoidal, splintery fracture. It commonly occurs in the form of more or less irregular nodules in limestones. Chert is another name applied to flint occurring in this way. Flint is commonly fired and ground for use in pottery manufacture or else used as a grinding agent in tube mills. For the first utilization the flints may be of any shape, but for grinding purposes they must be rounded. Most of the flint pebbles used for grinding are obtained along the coast of France from Calais to Havre, along the southern coast of England, and on some portions of the coasts of Greenland, Denmark, and Norway. Here the flint pebbles occur in irregular nodules in the chalk cliffs, but become rounded by wave action on the beaches. Some German Portland cement manufacturers place irregular flints in the pans in which the clay and lime are washed and after they have become sufficiently rounded transfer them to the tube mills. Flints fired for use in pottery are usually gray to nearly black in their natural condition, but become perfectly white on burning and fracture somewhat, so that crushing and grinding are facilitated.

METHODS OF GRINDING.

In the grinding of the massive forms of quartz two general processes are used, which may be called the "wet process" and the "dry process."

In the wet process the quartz may be crushed just as it comes from the quarry, or it may first be highly heated in kilns and then fractured by turning upon it a stream of cold water. The first crushing is effected by jaw crushers, or if the quartz has previously been burned it may be crushed in chaser mills. In a few mills the chasers revolve in wet pans and are periodically stopped to allow the crushed quartz to be shoveled out. After crushing, it is ground in "wet pans" provided with a pavement of flat-faced quartz or quartzite blocks over which move several large blocks of similar material, the crushed quartz being pulverized between these blocks and the pavement. The grinding in wet pans usually occupies about 24 hours, the load ground in a single pan varying from 1,200 to 1,800 pounds. From the wet pans the paste-like mass of quartz and water is drawn into settling troughs, the first settlings being in some cases returned to the pans for finer grinding. From the settling troughs it is shoveled out upon drying floors heated by steam or hot air, or else it is dried in small pans which are placed tier on tier on heated racks constructed of steam pipes. Finally the dried material is bolted to various degrees of fineness and packed in bags for shipment, or it may be shipped in bulk.

In the dry method of treatment the quartz is usually crushed first in a jaw crusher and then between crushing rolls. Quartz to be used for filters and for abrasive purposes is then screened to various degrees of fineness and is packed in bags for shipment. In the manufacture of the finer grades for use in pottery, wood fillers, scouring soaps, etc., the material after leaving the roll crushers is ground in tube mills, either of the continuous or of the intermittent type. It is then graded to various sizes either by bolting or by a pneumatic process whereby the quartz powder is carried by a strong air current through a series of tubes and receptacles, the distance to which the quartz is carried being dependent upon its fineness.

USES.

Quartz of the kinds dealt with in this report is used for a great variety of purposes, the principal uses being in the manufacture of wood filler, pottery, paints, and scouring soaps. In pottery the quartz serves to diminish shrinkage in the body of the ware; it is used also in many glazes. Quartz for these purposes should be nearly free from iron-bearing minerals. In general the analysis should show less than one-half of 1 per cent of iron oxide. Finely ground quartz is used in paints in various proportions up to one-third of the total pigment used. Its chemical inertness prevents it from combining with other constituents of the paint and increases the resistance of the paint to the weather. Crystalline quartz is superior to silica sand for this purpose because the ground particles are highly angular and tend to attach themselves more firmly to the painted surfaces, thus giving the piant what is known as a "tooth" and after some wear affording a good surface for repainting. This angularity of the grains also renders the ground crystalline quartz superior to silica sand in the manufacture of wood fillers. In scouring soaps and polishers ground crystalline quartz is preferred to silica sand, not only because of its greater angularity, but because of its superior whiteness.

Massive quartz, crushed and graded to various degrees of fineness, is extensively used in the manufacture of sandpaper, sand belts, as a scouring agent, with sand-blast apparatus, etc. The qualities which render it particularly serviceable for these purposes are its hardness (No. 7 in the Mohs scale), which is slightly greater than that of steel, and its conchoidal fracture, the absence of definite cleavage planes causing it to crush to fragments with sharp, angular edges and corners. For such abrasive purposes massive quartz is far superior to sand or crushed sandstone, since the grains of the latter are likely to be more or less rounded. Blocks of massive quartz and quartzite are used in the chemical industry as a filler for acid towers and to some extent as a flux in copper smelting. Much ground quartz is used in filters, and some of the most finely pulverized grades are used in tooth powders and in place of pumice as a cleaner by dentists.

Within recent years crystalline quartz and also sand has been used to some extent in the manufacture of silicon and of alloys of silicon with iron (ferrosilicon), copper (silicon copper), and other metals. Ferrosilicon is largely produced in the electric furnace by using coke to reduce the quartz to the metallic state, and some iron ore or scrap iron to alloy with the silicon. The percentage of silicon in these alloys varies from about 10 to 80 per cent, according to the uses of the product. Ferrosilicon has been employed in the manufacture of steel as a deoxidizer and to prevent the formation of blowholes in steel ingots. Silicon is also produced in the electric furnace.[1] It is a brittle crystalline body with a dark silver luster. Its specific gravity is about 2.4 and its melting point 1,430° C. The commercial product contains small percentages of iron, carbon, and aluminum. The great affinity of silicon for oxygen renders it useful for the reduction of metals such as chromium and tungsten in the

[1] Tone, F. J., Production of silicon in the electric furnace: Trans. Am. Electro-Chem. Soc., vol. 7, 1905, p. 243.

electric furnace. It can readily be cast into rods, and because of its high electrical resistance, which is about five times that of carbon, it is used in the manufacture of rheostats and electrical heaters. Its resistance to nearly all acids, combined with the fact that it can be cast into molds, makes it possible also to use it in the manufacture of chemical ware. Silicon copper is used as a deoxidizer in making castings of copper and copper alloys.

Quartz may be fused in the electric furnace to make tubes, crucibles, dishes, and other articles which can be used for certain purposes in the chemical laboratory instead of porcelain and platinum wares. The fused quartz expands only very slightly when heated, its coefficient of expansion being about one-twentieth of that of glass. In consequence of this property, red-hot articles of fused quartz may be plunged suddenly into cold water without cracking. These wares soften only above 1,400° C. (2,552° F.). The principal drawback to the use of these wares, especially in quantitative chemical work, is that the somewhat rough character of their surfaces makes it difficult to wash thoroughly all material from the dishes.

PRODUCTION.

The production of quartz in 1910 showed a decrease of 53 per cent in quantity and of 22 per cent in value, as compared with 1909. This notable falling off is due to the diminished production of a number of producers, notably those quarrying quartz for use in copper smelting, and to the fact that one firm, the New England Quartz Co., with mine and mill at Roxbury Falls, Conn., ceased to operate. The market conditions were in general reported to be fair.

Most producers keep no record of the number of tons of their product used for different purposes, and it has 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. No flint was produced in this country in 1910.

As heretofore, the figures record the quantity sold rather than the quantity mined.

Production of quartz in the United States in 1909–10, by States, in short tons.

States.	Crude.		Ground.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
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 [a]	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
1910.						
Connecticut, Massachusetts, and New York	6,881	17,372	1,271	17,130	8,152	34,502
Pennsylvania and Maryland	5,909	11,390	8,198	61,651	14,107	73,041
Other States [b]	37,096	52,222	4,222	33,992	41,318	86,214
Total	49,886	80,984	13,691	112,773	63,577	193,757

[a] Includes Arizona, Massachusetts, Michigan, Tennessee, and Wisconsin.
[b] Includes Arizona, Michigan, Tennessee, and Wisconsin.

Production of quartz in the United States, 1906–1910, in short tons.

Years.	Crude.		Ground.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1906	[1] 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
1910	49,886	80,984	13,691	112,773	63,577	193,757

[1] Exclusive of abrasive quartz.

PRICES.

Pure crystalline quartz for use in the manufacture of pottery, abrasive soaps, paints, wood fillers, etc., brings usually from about $2 to $3.50 per long ton, crude, f. o. b. quarries, and the ground material brings from $6.50 to $10 per short ton f. o. b. mills, the price varying with fineness of grinding, distance from markets, etc. The purer varieties of quartzite used for similar purposes and for sandpapers sell, as a rule, at somewhat lower prices, the crude bringing from about $1 to $2 per long ton f. o. b. mines, and the ground from $6 to $8 per short ton f. o. b. mills. The finest grades of crystalline quartz ground to an impalpable powder and used for tooth powders, etc., may bring as high as $20 per ton f. o. b. mills. Imported French flints cost from $3.50 to $4 per long ton, f. o. b. Philadelphia, and can be delivered in Trenton, N. J., for less than $5 per long ton.

IMPORTS OF FLINT PEBBLES.

The imports for consumption of flint pebbles into the United States in 1910 were valued at $307,286 for the crude material, as against $301,547 in 1909 and $219,754 in 1908.

QUARTZ INDUSTRY BY STATES.

Arizona.—Miller Bros., operating near Dewey, in Yavapai County, and the Calumet & Arizona Mining Co., operating near Douglas, in Cochise County, continued to be the only producers in Arizona. The quartz was sold crude at a low price for lining copper converters. The production was somewhat less than in 1909.

Connecticut.—Beyond the fact that the New England Quartz Co. ceased to operate its quarry at Roxbury Falls in Litchfield County, there was nothing of interest in Connecticut. The production was notably less than in 1909. The quarries were described in detail in the report on the production of quartz and feldspar in 1907.[1]

Maryland.—There was no new development in the quartz industry in Maryland. The production was nearly the same as in 1909, and the product was used mostly for pottery but to a slight extent as an abrasive. The quarries were described in the report on quartz and feldspar in 1907.[2]

Massachusetts.—Quartz was quarried in Massachusetts by the Berkshire Mineral Co., near Blandford, in Hampden County, and

[1] Mineral Resources U. S. for 1907, U. S. Geol. Survey, 1908, pp. 846–847. [2] Op. cit., pp. 847–848.

in small quantity by the Enos Adams Co., near Cheshire, in Berkshire County. The production was considerably less than in 1909.

Michigan.—In Michigan the only producer was the Michigan Quartz Silica Co., with a mine at Ishpeming, in Marquette County, and mills at Ishpeming and at Milwaukee, Wis.

New York.—Crystalline quartz was produced in New York at only one locality, the Kinkle quarry, at Bedford, Westchester County. The Bedford deposit was described in detail in an earlier report by the writer.[1]

Pennsylvania.—There were no new developments in the quartz industry in Pennsylvania in 1910. The only producers were the Columbia Flint Co., of Marietta, with mine and mill near Bendersville, Adams County, and H. T. A. Rhodewalt, with mine at Cornog station, in Chester County. These properties were described in the report on the production of quartz in 1909.[2] The production in 1910 was nearly the same as in 1909.

Tennessee.—Quartzite quarried by the North Carolina Flux Co., near Etowah, Tenn., is sold to the Tennessee Copper Co. for use in copper smelting. A quarry formerly operated by the Tennessee Refining Co., near Black Fox, in Bradley County, is reported to have been purchased by Charles Weller. The production in 1910 was greatly below that for 1909.

Wisconsin.—The Wausau Quartz Co. continued the operation of its quarry and mill near Wausau. The Wausau Sandpaper Co. reported that in January, 1910, it sold its entire stock to the Wausau Quartz Co. and discontinued manufacturing.

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 production of feldspar in 1910 showed a slight increase over that for 1909. Connecticut, Maine, and Maryland showed notable increases; Pennsylvania showed a slight decrease. The demand for the higher grades of pottery feldspar was good, and in Maryland a number of small producers idle in 1909 resumed operations.

Of the total production recorded under the heading of feldspar, 9,612 short tons of ground material from New York, valued at $31,787, 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. About $3 per

[1] 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.

[2] Mineral Resources U. S. for 1909, pt. 2, U. S. Geol. Survey, 1911.

ton f. o. b. mills is obtained for this material. 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 1909–10, by States, in short tons.[a]

States.	Crude.		Ground.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1909.						
Connecticut	4,102	$13,311	9,542	$52,516	13,644	$65,827
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
Pennsylvania	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	25,506	70,210	51,033	354,392	76,539	424,602
1910.						
Connecticut	9,996	32,903	8,743	57,071	18,739	89,974
Maine	280	625	20,482	195,838	20,762	196,463
Maryland	7,457	25,290	2,520	22,050	9,977	47,340
New York	550	2,576	11,862	45,288	12,412	47,864
Pennsylvania	3,751	12,611	11,340	92,140	15,091	104,751
California, Massachusetts, Minnesota, and Virginia	2,621	7,960	1,500	8,100	4,121	16,060
Total	24,655	81,965	56,447	420,487	81,102	502,452

[a] Includes abrasive feldspar.

Production of feldspar, 1906–1910, in short tons.

Years.	Crude.		Ground.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
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	25,506	70,210	51,033	354,392	76,539	424,602
1910	24,655	81,965	56,447	420,487	81,102	502,452

[a] Exclusive of abrasive feldspar.

FELDSPAR INDUSTRY BY STATES.

CALIFORNIA.

The feldspar mine near Chualar, in Monterey County, Cal., which was being developed during 1909, produced several hundred tons of potash spar for pottery during 1910.

CONNECTICUT.

Connecticut produced over 5,000 tons more feldspar in 1910 than in 1909. Every producer reported an increase in production, except the Consolidated Feldspar Co., near Middletown, Conn., which did not operate during the year. Market conditions were good. Prices obtained within the State for crude spar varied from $2.75 to $3 per ton and for ground spar from $5 to $6.50 per ton, according to grade. The prices at Trenton, N. J., and other pottery centers were proportionately higher on account of the added freight charges.

MAINE.

The production of feldspar in Maine was somewhat greater than in 1909. A small amount of feldspar was produced at the Mount Mica tourmaline mine near Paris, in Oxford County. A small amount was also quarried at about 1 mile from South Paris, Oxford County. All of this material was ground by the Maine Feldspar Co. at Littlefield, near Auburn, Androscoggin County.

MARYLAND.

The larger producers in Maryland maintained about their usual output during 1910, but a number of the smaller producers, idle in 1909, having resumed operation, a notable increase in production in 1910 was the result. J. T. French, who operated feldspar quarries near Hollofield and Alberton, in Baltimore County, is out of business. A new quarry has been opened by C. W. Gosnell about three-fourths of a mile from Marriottsville, in Carroll County, but no spar was sold in 1910. Another new quarry was opened by Peach & Whelan at Notch Cliff and Glen Farm, in Baltimore County, and a small amount of spar was sold in 1910. The market conditions were generally reported to be good. Most of the standard or No. 2 grades brought prices ranging from $3.75 to $4 per ton crude f. o. b. at the mines. Practically the whole output was ground at Trenton, N. J., and Wilmington, Del., and was used in pottery manufacture.

MASSACHUSETTS.

In Massachusetts the Berkshire Mineral Co., successor to the Blandford Quarries Co., continued mining at its quarry near Blandford, in Hampden County. Its product was sold crude for use in pottery manufacture and in abrasive soaps.

MINNESOTA.

The Minnesota Mining & Manufacturing Co., idle in 1909, resumed operations in 1910 at its plant near Crystal Bay, in Lake County. The product was used entirely for the manufacture of abrasive paper.

NEW YORK.

In Essex County, northern New York, the Barrett Manufacturing Co., of Ticonderoga, and the Crown Point Spar Co., of Crown Point, continued to produce large quantities of crushed pegmatite for the manufacture of ready-roofing, poultry grit, etc. The Adirondack Spar Co., successor to the Claspka Mining Co., produced a small amount of pottery spar from its quarry near Batchellerville, in Saratoga County. Pottery spar was also quarried and ground by P. H. Kinkle's Sons, at Bedford, Westchester County. The production was somewhat larger than in 1909, but less than in 1908.

PENNSYLVANIA

The production of feldspar in Pennsylvania in 1910 was nearly the same in quantity and in value as in 1908, but the total value fell somewhat below that of 1909. The quarry of Moses B. Carpenter, near Toughkenamon, continued to be operated under lease by the Pennsylvania Feldspar Co., which ground the product in its mill at Toughkenamon. The quarry of Oscar T. Quarll, near Avondale, in Chester County, which was an important producer in 1909, operated only during January and February in 1910. The quarry of Lewis Good, near Avondale, which had a small output in 1909, was idle in 1910. The market conditions were reported by various producers as fair or good.

During the year a feldspar quarry was opened by the Edgmont Feldspar Co., of Philadelphia, in Edgmont Township, Delaware County. Analyses show the feldspar to be of the potash variety. A mill with a capacity of about 6,000 tons a year is being erected near the quarry.

VERMONT.

In Vermont no feldspar was marketed during the year from the quarry near Chester in Windsor County, and no mill for the treatment of the spar has been erected.

VIRGINIA.

Pegmatite dikes, containing feldspar as an important constituent, are quite widely distributed through the Virginia crystalline or Piedmont area, east of the Blue Ridge, where they are found intruded in the principal types of the older rocks of the area. Hardly a county within the Piedmont area is without them. Many of these dikes have been worked, but their exploitation has been mainly for mica and the feldspar obtained has been accessory and minor in amount. The more important localities are described below.

AMELIA COUNTY.

The pegmatites of Amelia County have long been known [1] as sources of mica, ordinary feldspar, gem varieties of feldspar, and numerous rare minerals. All the mines have, however, been idle for some time, and on account of the slumping of soil into the excavations the exposures are not good. Several feldspar and mica quarries are located near Amelia, a station on the Richmond & Danville division of the Southern Railway, about 36 miles southwest of Richmond. These deposits were visited by the writer in April, 1911.

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[1] Watson, T. L., Mineral resources of Virginia; published by the Virginia Jamestown Exposition Commission, 1907.

Pinchbeck quarry.—The Pinchbeck quarry is located about 3 miles northeast of Amelia and consists of a number of open pits and shallow shafts which have been worked principally for mica, although a few hundred tons of feldspar have been shipped. The property had been long idle at the time of the writer's visit, and the exposures were not good.

The country rock at this locality is a dark schist carrying abundant biotite and muscovite and showing much variation in trend. The soil which results from the weathering of this schist is brick red and by slumping into the pits has obscured many portions of the hard rocks which were exposed when the quarry was operated. This schist is intruded by masses of pegmatite, most of them dikelike in form and nearly vertical. Their trend is commonly nearly east and west. The differences in composition and texture in different dikes are not greater than those observed between different portions of the largest dike, and all probably belong to one period of intrusion.

The largest dike, and the only one which has been worked for feldspar, is exposed by an open pit about 100 feet long and 60 feet wide, which is now partly filled with water. The general trend of the dike is nearly east and west and it appears to be nearly vertical, cutting sharply across the foliation of the schists which here strike about N. 25° E. and dip 40° NW. At the west end of the pit the dike has a width of about 35 feet, but at the south end it forks into at least three branches separated by tongues of schist. The principal constituents of this dike are white to light-gray opaque quartz, light cream-colored potash feldspar, and muscovite. The texture and the proportions of the constituents are variable, the wall portions of the dike being in general relatively fine grained and rich in muscovite, while the central portions are composed of large masses of pure feldspar and quartz with little muscovite. The highly muscovitic zone is in places 12 feet wide and has yielded some commercial mica, but feldspar and quartz are present only in small crystals. In the central portion, on the contrary, some of the masses of pure feldspar are 4 feet across and are associated with masses of pure quartz of commensurate size. Unlike many pegmatite masses, the quartz and feldspar are rarely in graphic intergrowth. The quarry was equipped with whim and hand pump and the material was excavated by hand drilling.

A small pit which may be upon this same pegmatite dike is located about 500 feet east of the above. A few exposures on the bottom show pure feldspar masses, 2 to 3 feet across, and pure quartz of similar dimensions. Considerable muscovite has been taken from this pit. The width or trend of the dike here is not shown. This property is unusual in that feldspar may be obtained practically unmixed with quartz. The deposit as now exposed is not of large size, but the prospect is undoubtedly a promising one and worthy of further development. The associated quartz is also of good commercial grade.

The other openings have been worked only for mica.

Rutherford mine.—This mine is located about 1½ miles north of Amelia (2½ miles by road). The property was worked principally by a shaft and connecting drifts which were filled with water at the time of the writer's visit in April, 1911. Only wall rock was exposed in the shallow open pit, and the pegmatite could be studied only from fragments on the dump. The wall rock is a purplish-brown biotite schist. The pegmatite dike which intrudes this schist is entirely different in mineral character from the pegmatite at the Pinchbeck property already described. White quartz is abundant in pure masses of considerable size and also in intimate intergrowth with muscovite, which commonly preserves the same crystallographic orientation throughout the intergrowth. Most of the quartz is opaque, but in places it becomes transparent. Muscovite is abundant and is colorless. Much of it shows the imperfection known as fishbone structure, but some is clear, and sheets 22 by 24 inches are reported to have been cut. The feldspar is of several varieties; white soda feldspar, albite, occurs in two forms, first, as massive crystals showing striations in the principal cleavage faces—some of these crystals seen on the dump being a foot across—and, second, as masses of bladelike translucent to transparent bluish-white crystals interlocking irregularly so as to leave in places considerable open spaces between. The massive variety is very rarely intergrown graphically with quartz. Finally there occurs much microcline of the green variety known as amazon stone. The color varies from rather a pale-bluish green to a rich green. Muscovite plates are occasionally intergrown with the microcline along the principal cleavage planes.

This mine is reported to have been opened first in the early eighties. It was worked largely for mica, but much of the green microcline and of the translucent albite (moonstone) was marketed as gem material. The property has not been worked for many years. If used for pottery manufacture the two varieties of feldspar, microcline and albite, which melt at different temperatures, would have to be either separated from each other or else mixed in definite proportions in order to give uniform results when fused in the potter's kiln. The deposit will probably be of more value for other purposes than as a source of pottery feldspar.

Rarer minerals which have been found at this mine [1] are highly phosphorescent fluorspar, columbite, microlite, helvite, beryl, monazite, and apatite.

Jetersville mine.—The Jetersville mine was not visited by the writer but has been described by Watson.[2] It is located about three-fourths of a mile west of Jetersville, the next station southwest of Amelia. It was opened between 1880 and 1885 and was worked by a shaft and open cut. Operations ceased about nine years ago. The shaft attained a depth of 100 feet and had several drifts running from it.

The country rocks are a gneiss of granitic composition and a sheared, thinly schistose diorite. These are intruded by a pegmatite dike whose width at the open pit does not exceed 30 feet. Quartz, mica, and feldspar were marketed, the feldspar being ground at a small mill at the mine and used for the manufacture of pottery.

BEDFORD COUNTY.

A feldspar mine, worked for a short time in Bedford County by the Bedford Spar Co., is located on Otter River about half a mile south of Bells. It is reached by a 10-mile drive from Bedford, on the

[1] The Virginias, vol. 6, 1885, p. 24.

[2] Op. cit., pp. 283–284.

Norfolk & Western Railway. The quarry consists of two hillside pits, one 100 feet long, 30 feet wide, and 40 feet deep, and the other 40 feet by 35 feet and 50 feet deep. The wall rock is a dark quartz-muscovite-biotite schist, striking N. 35° E. and dipping 75° NW. Both pits are on the same dike of pegmatite, which has a width of 6 to 15 feet, strikes about N. 25° E., and is nearly vertical. The pegmatite is moderately coarse and is composed of white quartz, light cream-colored feldspar, much muscovite in crystals seldom over an inch across, abundant biotite, and some black tourmaline. Graphic intergrowths of quartz and feldspar are rare. The feldspar sample collected showed no striations, but on testing was found to belong to the soda variety albite. Much of the feldspar is of this variety, but potash feldspar is probably also present. No masses of pure feldspar over 6 inches across were seen. Several tons of feldspar were piled in stock piles, but very little appears to have been shipped. The iron-bearing minerals biotite and black tourmaline, which are detrimental for pottery, are so intimately associated with the feldspar at this quarry that it is not practicable to separate them in mining. This fact, combined with the small size of the pegmatite dike and the long distance from the railroad, justified the abandonment of the property. The equipment includes boiler house and sheds.

PRINCE EDWARD COUNTY.

Feldspar prospects in Prince Edward County, worked for a time by the Dominion States Mines Corporation, are located near Prospect, a station on the main line of the Norfolk & Western Railway. The larger prospect is located about one-fourth of a mile southwest of Prospect station. It consists of several open pits, the largest about 60 feet by 30 feet and 15 feet deep, distributed for about 400 feet along a pegmatite dike. At the time of the writer's visit in April, 1911, no work had been done for some time and the slumping in of the soil had obscured some of the exposures. The wall rock is a biotite gneiss striking nearly east and west and dipping about 30° S. The pegmatite is dikelike in form and at the largest pit has a width of about 20 feet. It is steeply inclined and trends about N. 10° W.

The minerals of the dike are gray quartz, pink potash feldspar (orthoclase or microcline), and small amounts of a white feldspar which slakes more rapidly than the pink on exposure and is probably the soda variety albite. Some of the mica is nearly colorless, but some has a pale brownish tint. No masses of pure feldspar more than a few inches across were observed, most of the material quarried being a graphic or an irregular intergrowth of quartz and feldspar, usually carrying some mica. The coarser portions grade into finer portions in which muscovite is much more abundant. Although possibly suited for certain uses, such as glazing, enamel ware, and the manufacture of opalescent glass, this spar can not be regarded as of high grade for pottery. The deposit opened is not of large size, although other deposits probably occur in the vicinity.

A second small prospect worked by this company is located about three-fourths of a mile east of Prospect station. The largest pit, which is only 10 feet by 20 feet and 10 feet deep, exposes several pegmatite dikes 3 to 5 feet wide, which are parallel in general to the foliation of the bordering schists. The pegmatite is similar in mineral composition to that at the last described quarry except that it contains abundant black tourmaline. Because of the small size of the dikes and of the presence of the black tourmaline the deposit has no present commercial value.

OTHER COUNTIES.

Feldspar has been obtained in the past at a number of the mica mines in Henry County, but little has been marketed and none is now being shipped. In 1908 some development work was in progress near Hewlett, in Hanover County. None of these quarries has been visited by the writer, and no detailed information regarding them is available.

TALC AND SOAPSTONE.

By J. S. Diller.

INTRODUCTION.

The talc industry has been well established for many years, and with but few reversals has gradually gained in production, reaching in 1910 a maximum output of 150,716 short tons, 10,906 tons more than the next largest production in 1907. It is gratifying to find the trade alive to all changes in demand and vigorous in the endeavor to extend the application of this useful mineral.

Talc is generally more or less distinctly foliated, but being both soft and plastic, it is readily battered into round grains in the pulverizing process. Owing to its genesis, some talc is fibrous and adapted to the rôle of binder, in which it ordinarily appears as a filler. The remarkably absorptive quality of talc with reference to certain oils, its plasticity and unctuousness, and its stability at high temperatures and in strong solvents make it a most useful mineral in many branches of commerce.

The modes of occurrence of talc and soapstone, their varieties and characteristics, and their uses were considered in the report for 1909 and need not be repeated here. It may be well, however, to note more particularly the hard minerals that are frequently associated with the talc and that tend to destroy its unctuousness and to consider briefly a method of milling by which most of this grit may be removed. The most common detrimental minerals are residuals of pyroxene or amphibole, from which the talc is derived by alteration, and their abundance is usually in proportion to the degree of alteration the rock has undergone. Where the rock is but little changed, there is much grit and but little talc; but where the alteration is complete, the grit generally disappears in forming the talc. Much of the talc rock when mined contains grit, and the material should be so milled as to separate the grit from the talc. This is a matter to which the large manufactures of talc have lately given much attention. The separation can be accomplished to a great extent by a careful selection of the rock to be milled, but if the grit is to be got rid of it must be separated after the rock is ground. The process which promises to be most successful in this respect may be characterized as the pneumatic process, as the separation is effected chiefly by air currents.

MILLING TALC.

The milling process to be employed in preparing soapstone and talc for market depends on the use to be made of the material.

Soapstone is quarried in large blocks from open pits and is milled by gang saws into slabs, of which laundry tubs and other articles are manufactured. The good material in the refuse of the soapstone mills and quarries is sometimes ground to flour.

Talc is mined generally in underground openings, the material being won and raised to the mill by mining methods. In the milling of talc a small portion of the high-grade material is sawed into various shapes and is then turned or carved into final forms, as gas tips, pencils, crayons, etc., but by far the greater portion of the talc mined is ground into flour.

The simplest and most primitive method of making talc flour is to crush the talc into small fragments, then to grind it, like wheat or other grain, between horizontal burrstones, and then to separate it into several grades by bolting. This method prevails in the small mills, and also as an adjunct in the larger mills, because of a certain trade characteristic called "finish" which it imparts to the flour.

In many of the mills a pulverizer of one form or another comes next to the crusher. The Sturtevant pulverizer is very commonly used, but the Raymond, the Abbe, and others have all been employed successfully.

The pulverizer that does work on the largest scale, because it presents the largest extent of efficient grinding surface with a given expenditure of energy, is the pebble mill, of which the tube mill and the conical mill are special forms.

The talc flour is made up of grains of many sizes, and for those uses requiring a uniform size of grain [mesh] it is necessary so to grade the flour that all the grains of the same grade may be of the same size. Bolting or screening has generally been resorted to, with partial success, as a means of grading, but much attention has been given also to the use of air currents for this purpose, and many forms of separators more or less pneumatic have been devised and patented.

A pneumatic process has been successfully applied for many years to the milling of asbestos, both in the United States and Canada; but when applied to talc, which is generally foliated instead of fibrous, the process has not always given satisfactory results.

Within the last few years Mr. F. K. Daggett, of the Massachusetts Talc Co., has successfully applied a modification of the Osborne pneumatic process of separation to talc and has secured flour remarkable for the uniformity in size of the particles in the finest grades. This success appears to the writer of so much importance to the talc industry that Mr. Daggett was asked and has consented to describe briefly his process for publication.

Pneumatic separation as applied to talc by the Massachusetts Talc Co., Zoar, Mass.—It has been claimed that a uniform mesh [grade] of material could only be obtained by the use of screens or bolters. This may be true in theory, but in practice actual results have demonstrated beyond question that a higher percentage of uniform given mesh can be and has been obtained by the pneumatic or air-float system than is possible by any screens, bolters, or other processes used.

The talc rock is fed into the crusher and crushed to $\frac{1}{4}$-inch size and under, then conveyed to ore bin, where it is discharged into vertical pulverizing, emery, and burrstone mill with center feed. Here it is finely ground, thence conveyed to loft storage, from which it is discharged into an octagonal collector whose bottom is funnel shaped; the ground material drops upon the apex of a conical spreader within the collector. The finer particles are caught up in the circulating air within in a whirling motion (the heavier naturally falling the quickest and returning through the funnel to the mill for regrinding) and carried around and within the collector until it is completely filled with fine particles. Here the first or heaviest air blast is applied by suction at a point about midway of the depth of the octagonal part of the collector. The material is thence withdrawn and discharged into a second collector, where it falls upon a second conical spreader and then repeats its first movement. The funnel-shaped hopper at the bottom of this second collector discharges the heavier particles into bags ready for shipment.

A second lighter blast is applied by suction within the second collector about midway between center and top of the octagonal part and the particles are withdrawn and carried into the third collector, this latter being of somewhat larger dimensions (as the particles have become very small and require more space for equalizing the float), with hopper bottom, where the next finer grade is collected and bagged for shipment (for, as before, the coarsest particles fall to the bottom).

The third or final air blast, of greater force than either the first or the second blasts, is here applied by suction, the intake being at the extreme top of the octagonal part of the collector. The lightest or impalpable particles float nearer the top and, as before, the heavier particles descend into another hopper ready for bagging, thus furnishing our third finer grade, the impalpable particles being discharged into flumes of porous textile, thus permitting the air to escape sufficiently to prevent any back pressure within the system, and the material is discharged into hopper, ready for bagging. This is the last and finest mesh obtainable.

We have thus obtained four entirely different sizes of finished product, four entirely different colors, the last being the lightest, the first the darkest, and each of a uniform mesh, the entire process of which is automatic in operation and from the time the rock is fed into the crusher until all four grades are milled requires less than 10 minutes.

Any desired meshes can be obtained by this process by regulating the pulverizing mill and then opening or closing the blast gates that control the vacuum or velocity required.

PRODUCTION.

The productive talc and soapstone belt of the United States is limited almost exclusively to the Atlantic States from New York and Vermont to Georgia. Outside of this belt there is only a small production in California.

A new record was made in raising the maximum annual production of 1910 to 150,716 tons, an increase of 16 per cent in quantity and 30 per cent in value as compared with that produced in 1909. The increased production was chiefly from New York, but partly also from Vermont, Pennsylvania, and Georgia.

New York increased 48 per cent in quantity of output and much more in relative value. Georgia trebled its production. Vermont gained 10 per cent in production and 14 per cent in value. In Massachusetts, although the quantity reported sold was somewhat less than in 1909, the actual production increased about 16 per cent in quantity and 7 per cent in value. There was a decline in the production sold in all the other States with the exception of Rhode Island, but in New Jersey the decline was scarcely appreciable. In Virginia, which is the great soapstone State, the decline in quantity and value was only about 2 per cent; in North Carolina it was 35 per cent; and in Maryland and California it was about 50 per cent.

The variation in the production of the different States is in part at least due to variations in the immediately available deposits, but in general it may be said that the deposits are extensive and show no signs of depletion.

In the best grades of talc the United States is deficient. They are imported chiefly from France and Italy.

The growth of the talc industry in the United States is illustrated by the following table, which shows the annual production from 1880 to 1910:

Production of talc and soapstone in the United States, 1880–1910, in short tons.

Years.	Quantity.	Value.	Years.	Quantity.	Value.
1880–1900	969,928	$11,224,652	1906	120,644	$1,431,556
1901	97,843	908,488	1907	139,810	1,531,047
1902	97,954	1,140,507	1908	117,354	1,401,222
1903	86,901	840,060	1909	130,338	1,221,959
1904	91,189	940,731	1910	150,716	1,592,393
1905	96,634	1,082,062			

Talc and soapstone are usually marketed either as rough or crude from the mine, as sawed into slabs, as manufactured articles, or as ground talc. In the following table the quantities produced and the value and average price per ton of each class are given for the years 1907–1910:

Production of talc and soapstone in the United States according to varieties, 1907–1910, in short tons.

Condition in which marketed.	Quantity.	Value.	Average price per ton.	Quantity.	Value.	Average price per ton.
	1907			1908		
Rough	25,538	$34,625	$1.36	3,013	$7,819	$2.60
Sawed into slabs	4,822	91,668	19.01	3,406	71,048	20.86
Manufactured articles [a]	23,484	648,475	27.61	16,336	442,624	27.10
Ground [b]	85,966	756,279	8.80	94,599	879,731	9.20
Total [c]	139,810	1,531,047	10.95	117,354	1,401,222	11.94
	1909			1910		
Rough	27,412	$79,499	$2.90	15,425	$56,872	$3.69
Sawed into slabs	2,893	54,009	18.67	9,352	78,042	8.34
Manufactured articles [a]	22,646	502,447	22.19	22,363	503,391	22.51
Ground [b]	77,387	586,004	7.57	103,576	954,088	9.21
Total [c]	130,338	1,221,959	9.38	150,716	1,592,393	10.57

[a] 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.
[b] For foundry facings, paper making, lubricators for dressing skins and leather, etc.
[c] Exclusive of the quantity used for pigment, which is included among mineral paints.

In 1910 nearly 11 per cent of the material was sold as crude from the mine, about 6 per cent as sawed into slabs, 15 per cent as manufactured, and 69 per cent as ground. The sale of rough talc and also of manufactured articles declined during the year, while the sale of slabs and of ground talc advanced greatly.

In the following table those 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 among the States. Its product is ground talc, while that of Virginia, which ranks third, is almost wholly of manufactured articles of soapstone. Vermont ranks second and produces both talc and soapstone.

Production of talc and soapstone, 1908–1910, by States, in short tons.

States.	1908		1909		1910	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Massachusetts	(a)	(a)	9,057	$48,729	7,475	$52,204
New Jersey and Pennsylvania	4,648	$29,118	13,900	61,967	13,192	62,833
New York	70,739	697,390	48,536	359,957	71,710	728,180
North Carolina	3,564	51,443	5,956	77,983	3,887	69,805
Vermont	10,755	99,743	23,626	120,329	25,975	136,674
Virginia	19,616	458,252	26,511	523,942	25,908	510,781
Other States [b]	8,032	65,276	2,752	29,052	2,569	31,916
Total	117,354	1,401,222	130,338	1,221,959	150,716	1,592,393

[a] Included in "Other States."
[b] Georgia, Maryland, Massachusetts, and Rhode Island, in 1908; California, Georgia, Maryland, and Rhode Island, in 1909 and 1910.

IMPORTS.

The total imports for consumption in 1910 were 8,378 short tons, valued at $106,460. The quantity imported was nearly double that of 1909, but lacked 1,622 tons of being as large as the imports of 1907.

Talc imported into the United States, 1902–1910, in short tons.

Years.	Quantity	Value.	Average price per ton.	Years.	Quantity.	Value.	Average price per ton.
1902	2,859	$35,366	$12.36	1907	10,060	$126,391	$12.56
1903	1,791	19,677	10.99	1908	7,429	97,096	13.07
1904	3,268	36,370	11.13	1909	4,417	56,287	12.74
1905	4,000	48,225	12.05	1910	8,378	106,460	12.71
1906	5,643	67,818	12.02				

The imported talc came from Italy, France, Austria-Hungary, Canada, England, Belgium, and Germany. The most of it came from Italy and the remainder from the other countries in the order stated. Canada furnished 536 tons.

The import duty on ground and manufactured talc is 35 per cent. It is proposed, however, in the reciprocity treaty now under consideration in Congress, to admit talc not for toilet use free from Canada.[1]

The production of talc by Canada in 1910[2] was 7,112 short tons, valued at $22,308. Ontario[3] reported only one producing mine and mill which are equipped with electric power, in Hastings County, near Madoc, on the Grand Trunk Railroad. The mill has a capacity of 16 to 20 tons of finished talc per day. The yield of the mine in 1909 was about 4,350 tons.

[1] A bill to promote reciprocal trade relations with the Dominion of Canada, and for other purposes (H. R. 22), 62d Cong., 1st sess., Apr. 4, 1911.
[2] Canadian Dept. Mines, preliminary report on the mine production of Canada during the calendar year 1910, p. 7.
[3] Nineteenth Rept. of Ontario Bur. Mines, pt. 1, p. 127.

TALC DEPOSITS, BY STATES.

CALIFORNIA.

California is the only State west of the Allegheny Mountains producing talc, and its production is small. The mine and mill are in Kings County, near Hanford. The output is wholly ground, and in 1910 was but little more than half of that in 1909.

GEORGIA.

In Georgia the talc industry centers about Chatsworth, on the Louisville & Nashville Railroad, where the mills of the Georgia Talc Co. and the Cohutta Talc Co. are located. Their mines are in the schist belt a few miles to the southeast. Part of the output is sawed into crayons or pencils, but the greater part is ground. In 1910 the production was more than three times that of 1909, and nearly half of it was manufactured into crayons and pencils, which were of much greater value than the ground talc.

MARYLAND.

The Deland Mining & Milling Co., at Bald Friar, on Susquehanna River and the Pennsylvania Railroad, a few miles above Havre de Grace, was shut down part of the time because of preparations to install a tube mill; hence the production in 1910 was less than in 1909. The mine is on a steep, rocky, but open slope of the river terrace, facing the mill, and all operations are greatly facilitated by gravity. Talc is the chief product of the mine, but some feldspar is obtained. The talc forms irregular schistose masses in the altered basic igneous rocks included under serpentine on the geologic map of Cecil County by the State Geological Survey of Maryland.

MASSACHUSETTS.

Of the three producers in Massachusetts, the output of the Berkshire Talc Co., of Dalton, and the Foliated Talc Co., of Rowe, are small as compared with that of the Massachusetts Talc Co. at Zoar. All of the companies increased their yield about 16 per cent during the year, but owing to the large stock (3,000 tons) remaining at the end of the year the quantity reported as actually sold was less than in 1909. The mill of the Massachusetts Talc Co. is on Deerfield River and the Fitchburg Railroad at Zoar, Mass., and the mine is in talc schist on the tableland 4 miles to the north and connected by good wagon roads. Under the general management of Fred K. Daggett, the company has operated a mill in which a pneumatic process of separating various grades of talc products has been very successfully employed. This matter is of so much importance in the talc industry that on request Mr. Daggett has kindly furnished the description of his process given on a preceding page. Unfortunately, the mill of the Massachusetts Talc Co. at Zoar was completely destroyed by fire on March 24, 1911. A new mill is being built at the same place and is expected to be ready for operation before the end of June, 1911.

NEW JERSEY.

There is but one operator in New Jersey, the Lizzie Clay & Pulp Co., near Phillipsburg. The product was all ground, and the output was somewhat less in 1910 than in 1909.

The geologic relations of the talc deposits of this region are of especial interest and have been fully described by F. B. Peck in the annual report of the State geologist of New Jersey for 1904.

NEW YORK.

New York maintained its ascendency in the talc industry by a production in 1910 of 71,710 tons, an increase of more than 47 per cent over the output reported by the census for 1909.

The annual production of talc in New York from 1901 to 1910, as compared with that of all the other States of the United States combined, is given in the following table with the average annual price per ton of the New York talc:

Production and value of the talc and soapstone of New York, 1880–1910, as compared with that of all the other States combined, in short tons.

Years.	New York.			All other States.	
	Quantity.	Value.	Price per ton.	Quantity.	Value.
1880–1900	629,925	$5,933,501	$9.42	340,003	$5,291,151
1901	69,200	483,600	6.99	28,643	424,888
1902	71,100	615,350	8.65	26,854	525,157
1903	60,230	421,600	7.00	26,671	418,460
1904	64,005	507,400	7.93	27,184	433,331
1905	56,500	445,000	7.88	40,134	637,062
1906	61,672	557,200	9.03	58,972	874,356
1907	67,800	626,000	9.23	72,010	905,047
1908	70,739	697,390	9.86	46,615	703,832
1909	48,536	359,957	7.42	81,802	862,002
1910	71,710	728,180	10.15	79,006	864,213
Total	1,271,417	11,375,178	8.95	827,894	11,939,499

There are five talc companies operating in the State, four in the vicinity of Gouverneur, St. Lawrence County, and one near Natural Bridge, Lewis County. All of these mines occur in talc and hornblende schists associated with crystalline limestone that trends northeast and southwest within the borders of the Adirondack gneiss. The genetic relations of these talc bodies have been described and the literature concerning them referred to in previous reports.

The International Pulp Co. is the most important single producer, not only in this State, but in the United States. Its principal mines are near Talcville, but most of its mills are in the vicinity of Hailesboro, on the branch railroad between Talcville and Gouverneur. The destruction of the United States mill by fire in November, 1910, was more than counterbalanced by the increased production of the other mills. The United States Talc Co., with a mine near Talcville, and the Union Talc Co., with mines some distance from the railroad south of Fowler, are associated with the International Pulp Co., and send their talc to the same mills. The joint output of these three largest producers of ground talc in the United States gives to the association a dominant influence.

The Ontario Talc Co. reopened its mine and continued to operate its mill near Fullerville. The mine and mill being some distance from one another and from the railroad, all transportation is by wagon road, and the products are hauled 11 miles to Gouverneur for shipment. The total output of the company fell off in 1910, but the average price per ton advanced, indicating, apparently, improvement in the quality of the talc—a view which is confirmed by the high grade of material mined in the early part of 1911.

The large new mill and hydroelectric power plant of the Uniform Fibrous Talc Co., near Talcville, is nearing completion, and partial operation began in the spring of 1911. The mine by the mill and railroad at Wintergreen Hill is on approximately the same talc belt as the properties of the International Pulp Co. and the United States Talc Co., only a short distance farther to the northeast, and is most favorably located for economical operation.

A new feature has recently been added to the talc industry of New York in the manufacture of electric griddles from what is claimed to be a body of remarkably pure massive talc near the southwestern end of the talc belt in the vicinity of Natural Bridge, in Lewis County. A small part of the material was reported as sawed into slabs for griddles, but the greater portion was ground.

NORTH CAROLINA.

There were seven talc companies producing in the State during 1910. Most of the small producers increased their output, but the production of the principal operators decreased decidedly, so that in the total production of the State there was a falling off of nearly 35 per cent, or from 5,956 tons in 1909 to 3,887 tons in 1910. These figures for 1910 include both talc (1,490 tons) and pyrophyllite (2,397 tons), and there were four producers of pyrophyllite and three of talc. The average price of the talc, including the manufactured and the ground as well as that sold in the rough state at various mines, was over $17 per ton. The average price of the ground talc per ton was about $11; that of pyrophyllite was nearly $10 per ton. Most of the talc came from Swain County where the chief producer, the North Carolina Talc Mining Co., at Hewitt, has been mining talc for many years. Near by in the same county, the Nantahala Marble & Talc Co. has been operating, and there was a small production by G. F. Smith, near Piney Creek, in Allegheny County. The production of pyrophyllite was confined to Moore County in the vicinity of Glendon. The Glendon Mining & Manufacturing Co., the American Talc Co., the Croatin Co., and the McDonald & Tillman Co. operated in the same region. The last two companies sold their output in the rough, but the other companies, which were the larger producers, sodl their product ground.

The Alba Mineral Co. and the Beta Fiberizing Co., which were more or less active in 1909, reported no production in 1910.

PENNSYLVANIA.

There were three talc companies in operation in Pennsylvania in 1910, namely, J. O. Wagener & Co. and C. K. Williams near Easton, and the Atlas Mineral & Machine Co. at Gladwyne, 6 miles northwest of Philadelphia. The total output for the State remained about as in 1909. All of the material near Easton was ground, but about half of that near Philadelphia was sold as quarried.

The deposit at Easton is remarkable. It extends northeast across the Delaware into New Jersey,[1] and the mine of the Lizzie Clay & Pulp Co., 2 miles up the river from Phillipsburg, is on the same belt and only a short distance away from the quarries of C. K. Williams and J. O. Wagener & Co., near Easton, Pa. The talc schist of the belt occurs in irregularly shaped schistose masses, which generally strike northeast and southwest and are associated with a variable greenish rock, whose color is mainly due to the presence of serpentine. Certain phases of it contain prominent crystals of mica or reddish feldspar in spots or veins, which give the rock when polished for ornamental purposes remarkable beauty. The material from the Williams quarry is sold in large blocks as quarried, but much of it in small fragments, although decidedly green, contains more or less talc and is ground and marketed as verdolite—the name which is perhaps generally applied also to the marble.

The talc is carefully assorted at the mines into several grades, and the best grade is cleaned with steel brushes or otherwise so as to free it from all depreciatory adherents. The same is true of the verdolite. It is then hauled in wagons about a mile to the Williams mills, on Bushkill Creek, where it is ground and prepared as talc or verdolite for a variety of uses. Much of the waste product is crushed at the quarry for road material.

The abundance of good material of great variety in large quarries favorably located for economic working and a fair demand for the product indicate for this industry a larger development.

RHODE ISLAND.

The Rode Island Soapstone Co. is the only company operating in the State. Its mine is located at Manville, in Providence County, and the production, though small, was increased nearly 5 per cent in 1910 as compared with the output of 1909. A little more than half of the product was manufactured and the remainder was ground.

VERMONT.

Vermont ranks second not only in total production, but also in the production of ground talc and of soapstone. There were six producers in Vermont contributing to an output of 25,975 tons having a total value of $136,674, as compared with an output of 23,626 tons valued at $120,329 in 1909, a gain of nearly 10 per cent in quantity. Most of the talc was ground, but 4,525 tons were sold crude.

For years the production of soapstone in Vermont has been an important part of the industry. The production in 1910 showed an increase over that of 1909, and two companies, the Union Soapstone Co., of Chester Depot, and the Vermont Soapstone Co., of Perkinsville, both reported production.

The four largest producers were the Union Soapstone Co., and the American Soapstone Finish Co., at Chester, the Eastern Talc Co., at East Granville, and the Standard Talc Co., at Rochester. One other company operating was the Vermont Talc & Soapstone Co.,

[1] Ann. Rept. Geol. Survey New Jersey for 1904, 1905, pp. 163-185

of Windham. This property, although it may be reached by good wagon roads, is about 10 miles from the railroad. In every other respect it is most advantageously located for economic work, and the mill is practically new and a good one. F. K. Daggett has recently assumed the management of this property, which is increasing its production. With so large a number of producers in New England competition has been keen, and prices are reduced to the lowest margin of profit.

VIRGINIA.

Virginia ranks third in the quantity of its total production, but unlike New York the output is almost entirely soapstone, in the production of which it ranks first, far surpassing Vermont. The production for 1910 was 25,908 tons, valued at $510,781 from eight producing mines—a decline of about 2 per cent from the production of 1909. Although there was a decline in the total output, about half of the mines operating increased in production. Only a small quantity, 1,388 tons, of the output for 1910 was sold as crude talc from the mines, and 2,502 tons was sold in the form of slabs as manufactured soapstone. More than 82 per cent was sold as manufactured products of soapstone, chiefly as laundry tubs.

The great quarries or open mines are all on the soapstone belt running through the State northeast and southwest from Orange County through Albemarle and Nelson Counties, and recurring at Lynch station in Campbell County, a second belt occurs at Jetersville in Amelia County, about 50 miles southeast of the first belt.

The Virginia Soapstone Co., with quarries at Schuyler, and mills at Schuyler in Nelson County and at Alberene in Albemarle County, is the largest producer and has a branch railroad connecting it with the main line of the Southern Railway at Rockfish, as well as with the Chesapeake & Ohio Railway at Warren on James River. The deeper portion of the quarry has been practically abandoned at Schuyler and the openings have been extended to the northeast. The Old Dominion Co., a few miles northeast of Schuyler toward Alberene, is in the same belt with equal shipping facilities and is working in a new opening. Southwest of Schuyler in the same belt the Climax, the Phoenix, and the Piedmont have been more or less active producers. The Eureka, the National, and the Austin did not report any production in 1910. The Phoenix, with its increased machinery, has enlarged its activities.

A small production of soapstone was reported from near Lynchburg, Campbell County, but the operations in Amelia County appear to have been suspended in 1910. In Fairfax County the small but continued production of crude talc has somewhat increased.

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